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Thomas et al.

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[45] **Date of Patent: Nov. 2, 1999**

[54] **SUBTERRANEAN WATER COLLECTION AND DELIVERY DEVICE AND SYSTEM**

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[73] Assignee: **Morgan Concepts, Inc.**, Farmington Hills, Mich.

[*] Notice: This patent is subject to a terminal disclaimer.

[21] Appl. No.: **08/902,530**

[22] Filed: **Jul. 29, 1997**

Related U.S. Application Data

[63] Continuation-in-part of application No. 08/687,634, Jul. 26, 1996, Pat. No. 5,795,100.

[51] **Int. Cl.**[6] **E02B 13/00**; A01G 29/00

[52] **U.S. Cl.** **405/45**; 47/48.5; 405/36; 405/50

[58] **Field of Search** 405/45, 36, 50, 405/43; 47/48.5

[56] **References Cited**

U.S. PATENT DOCUMENTS

419,242	1/1890	Brown .	
1,490,865	4/1924	Van De Velde	47/48.5
1,791,873	2/1931	Neiman .	
1,923,677	8/1933	Lovett, Jr. .	
1,971,390	8/1934	Yahres .	
2,105,800	1/1938	Watkins	47/48.5 X
2,145,934	2/1939	Kingman	405/50 X
2,380,721	7/1945	Brigden .	
2,755,985	7/1956	Finegan	47/48.5 X
3,319,379	5/1967	Groeber et al. .	
3,755,966	9/1973	Smith .	
3,821,863	7/1974	Chan .	
4,056,898	11/1977	Brucato et al. .	
4,061,272	12/1977	Winston	405/45
4,454,684	6/1984	O'Hare	47/48.5 X
4,726,143	2/1988	Steinbeck .	
4,753,394	6/1988	Goodman	47/48.5 X
4,785,575	11/1988	Shioi .	
5,172,515	12/1992	Lapshansky et al.	47/48.5
5,347,753	9/1994	Dall .	
5,533,300	7/1996	Kesler .	

FOREIGN PATENT DOCUMENTS

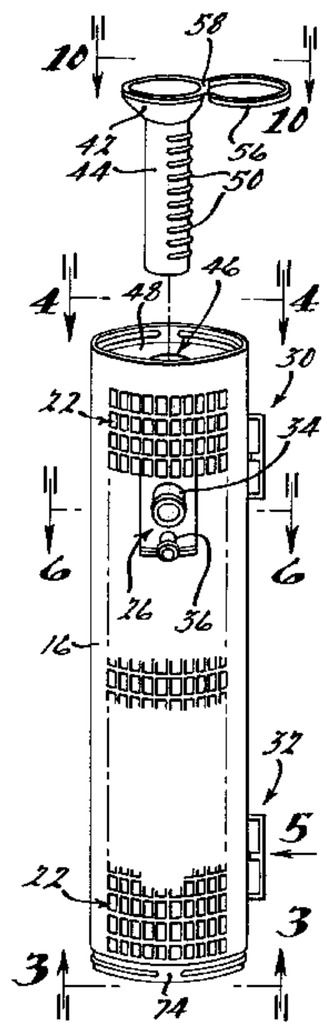
622630	6/1961	Canada .	
0193167	9/1986	European Pat. Off.	47/48.5
2 249 463	5/1992	United Kingdom .	

Primary Examiner—Dennis L. Taylor
Attorney, Agent, or Firm—Harness, Dickey & Pierce, P.L.C.

[57] **ABSTRACT**

In accordance with the teachings of the present invention, a subterranean water and air collection and delivery device for facilitating the collection and delivery of air, natural ground water, manually supplied water, and/or pressurized water from an irrigation system to the roots of plants is provided. The device includes a plastic enclosure member including a plurality of apertures and having an interior volume within which water and air is collected and redirected. A porous insert member is located within the interior volume of the plastic enclosure member and substantially occupies the entire volume for facilitating collection and delivery of water and air while substantially preventing surrounding ground material from entering the interior volume of the enclosure member. The enclosure member is buried at a predetermined depth near the roots of the at least one plant such that the apertures throughout the device provide ingress and egress for water and air to and from within the interior volume at various depths for the efficient delivery of the water and air to the roots of the at least one plant and for reducing the potential for non-point source pollution.

22 Claims, 7 Drawing Sheets



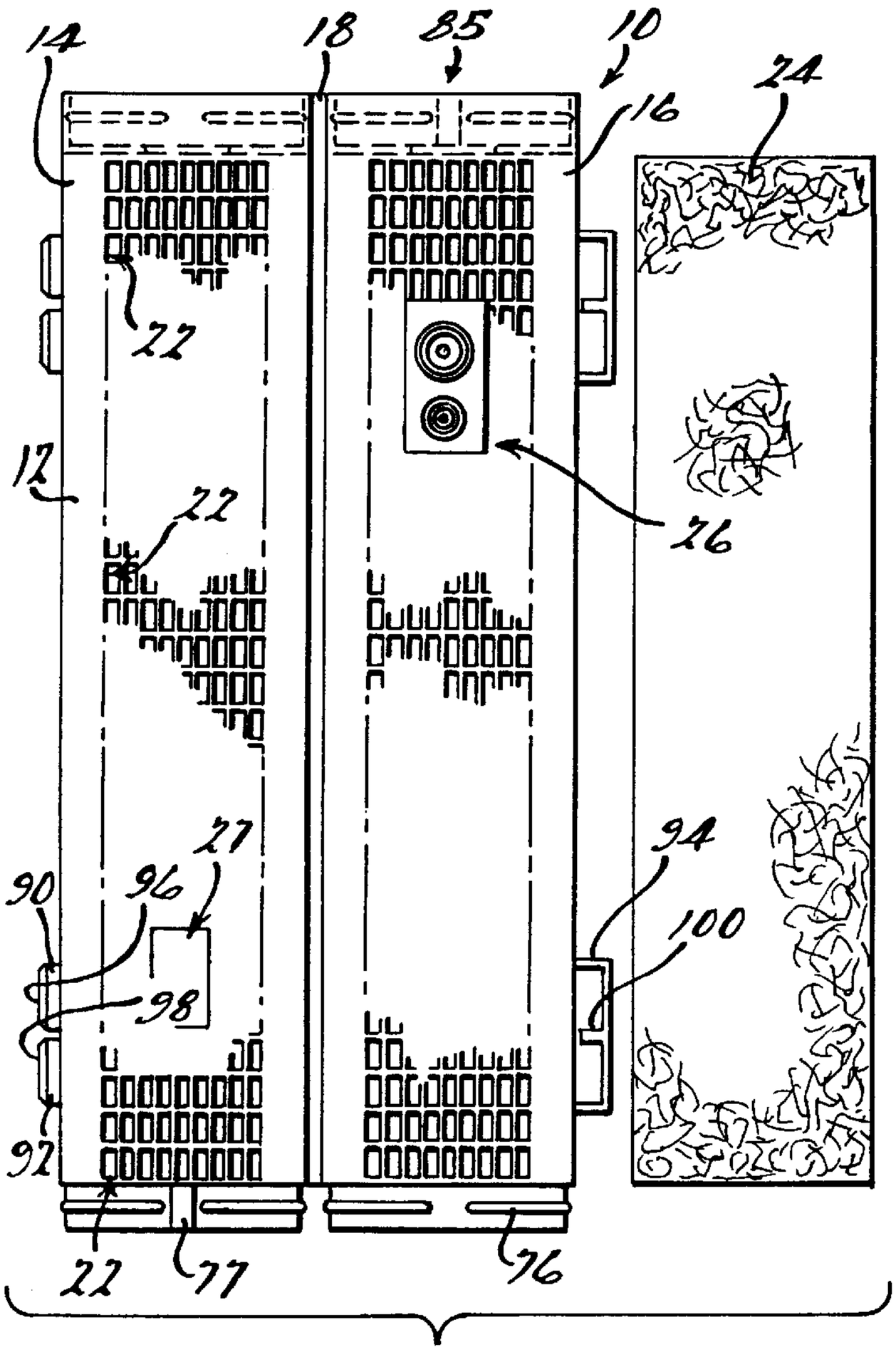


Fig. 1.

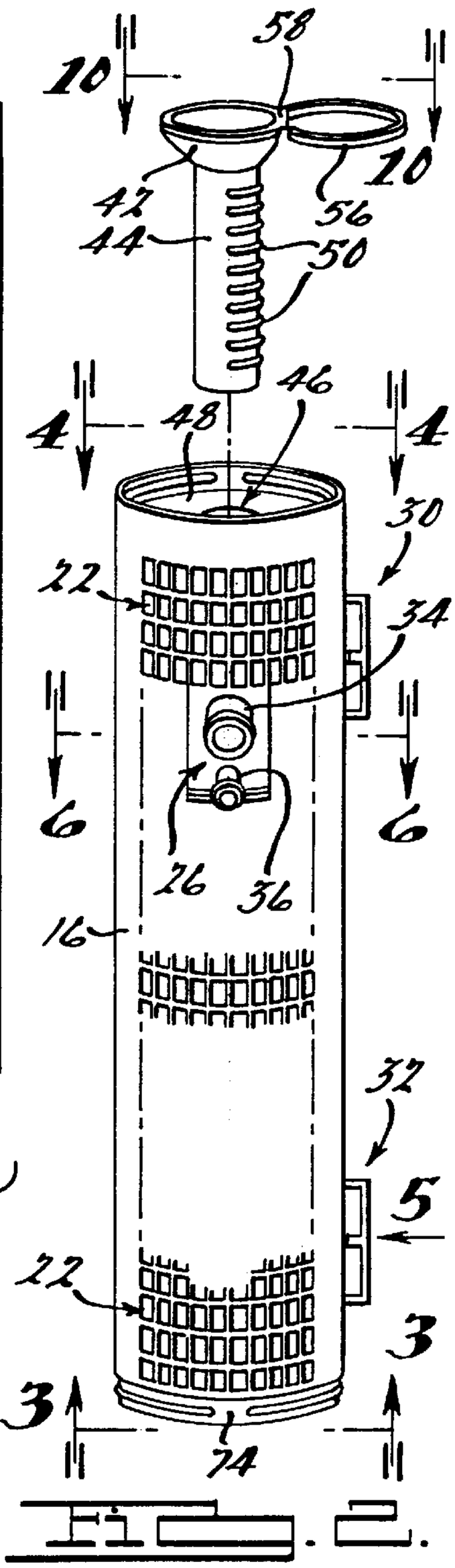
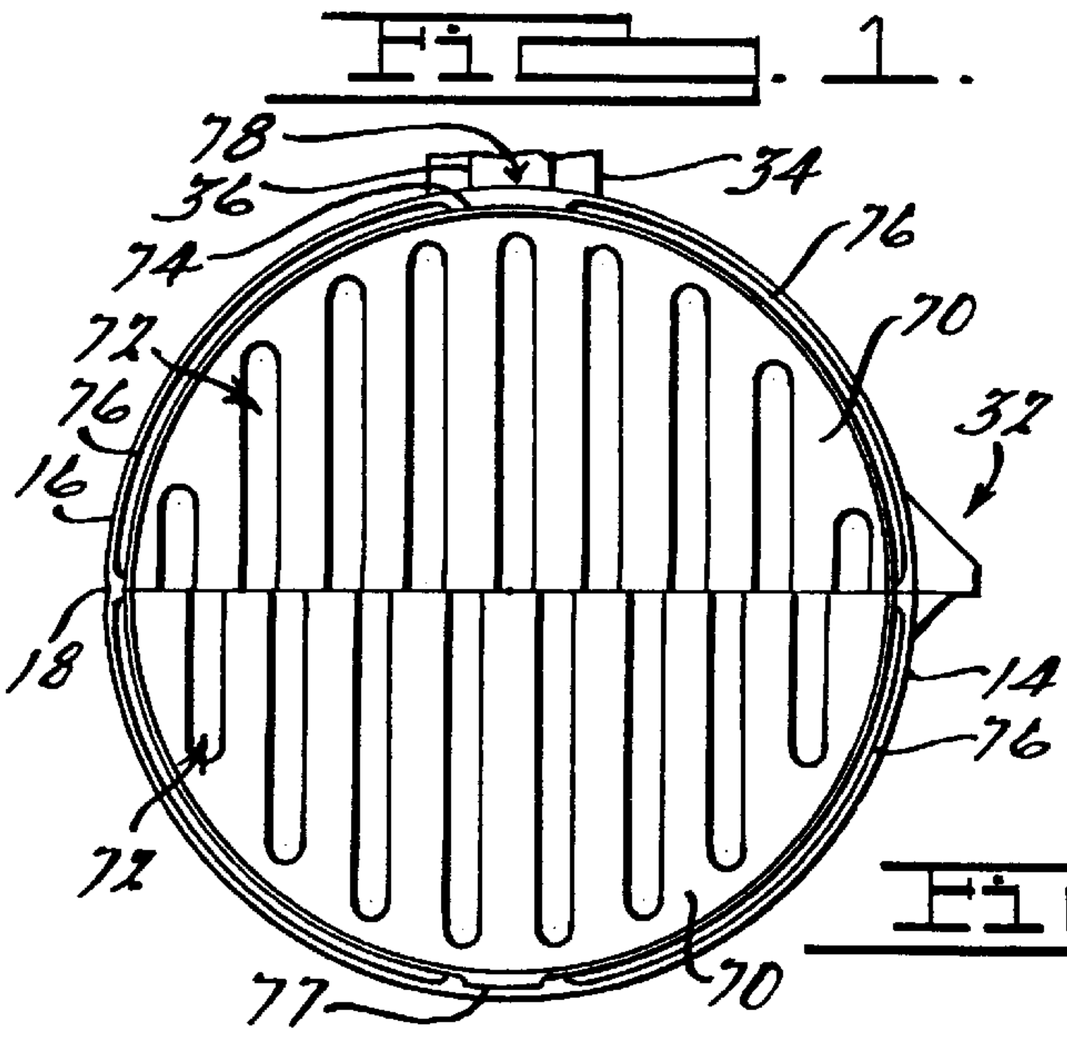


Fig. 2.



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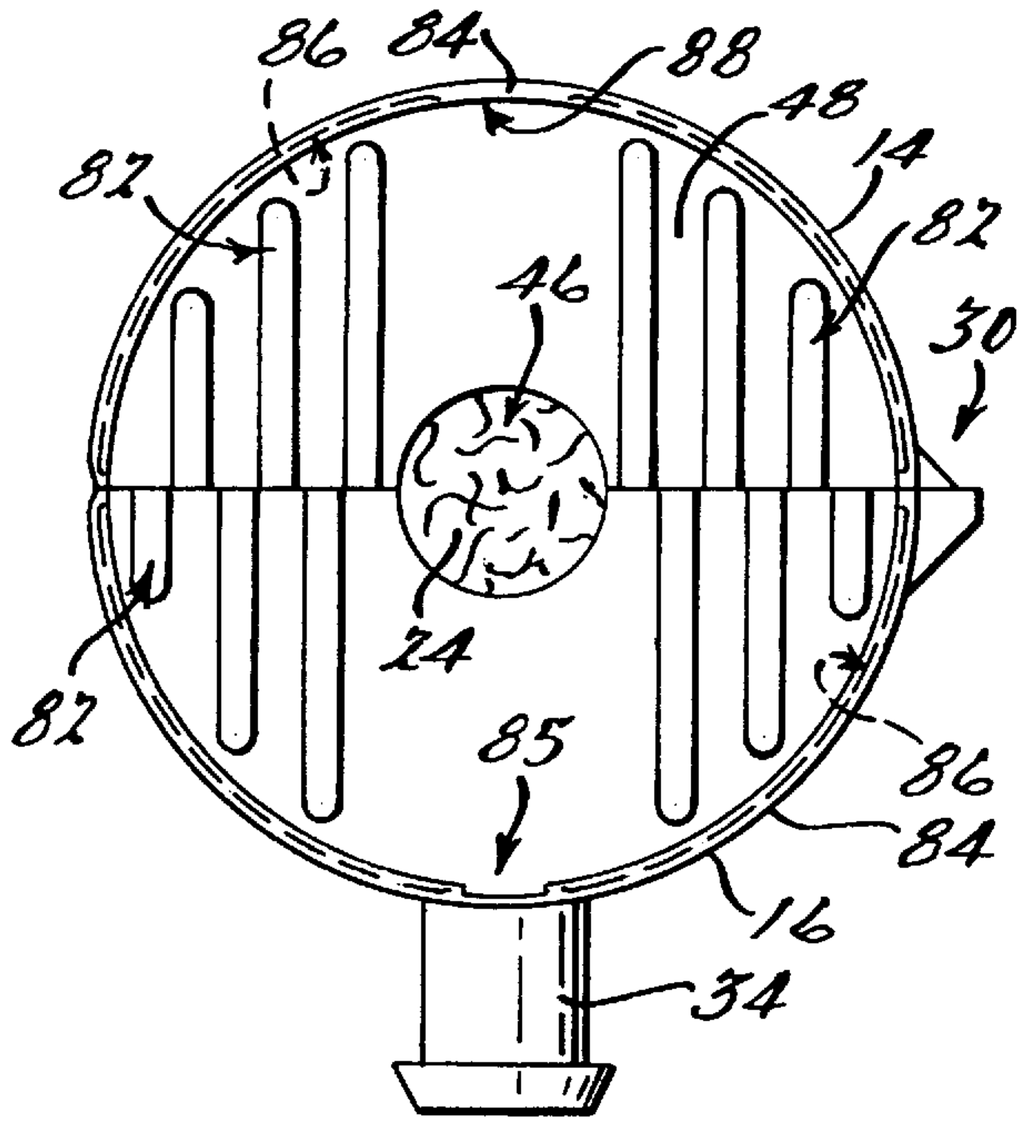

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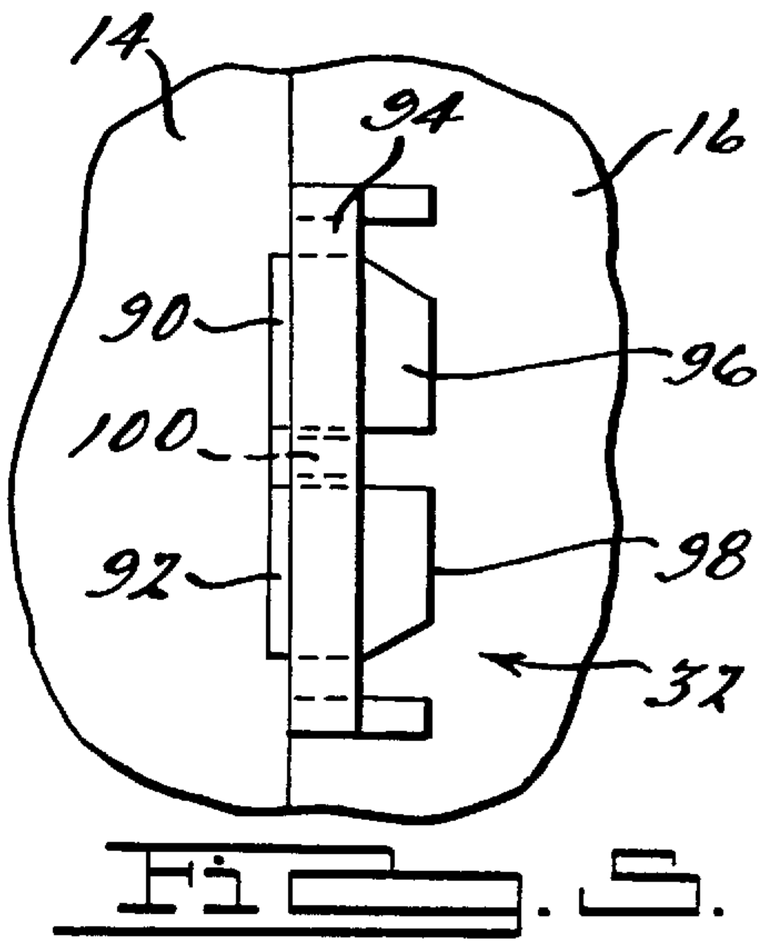

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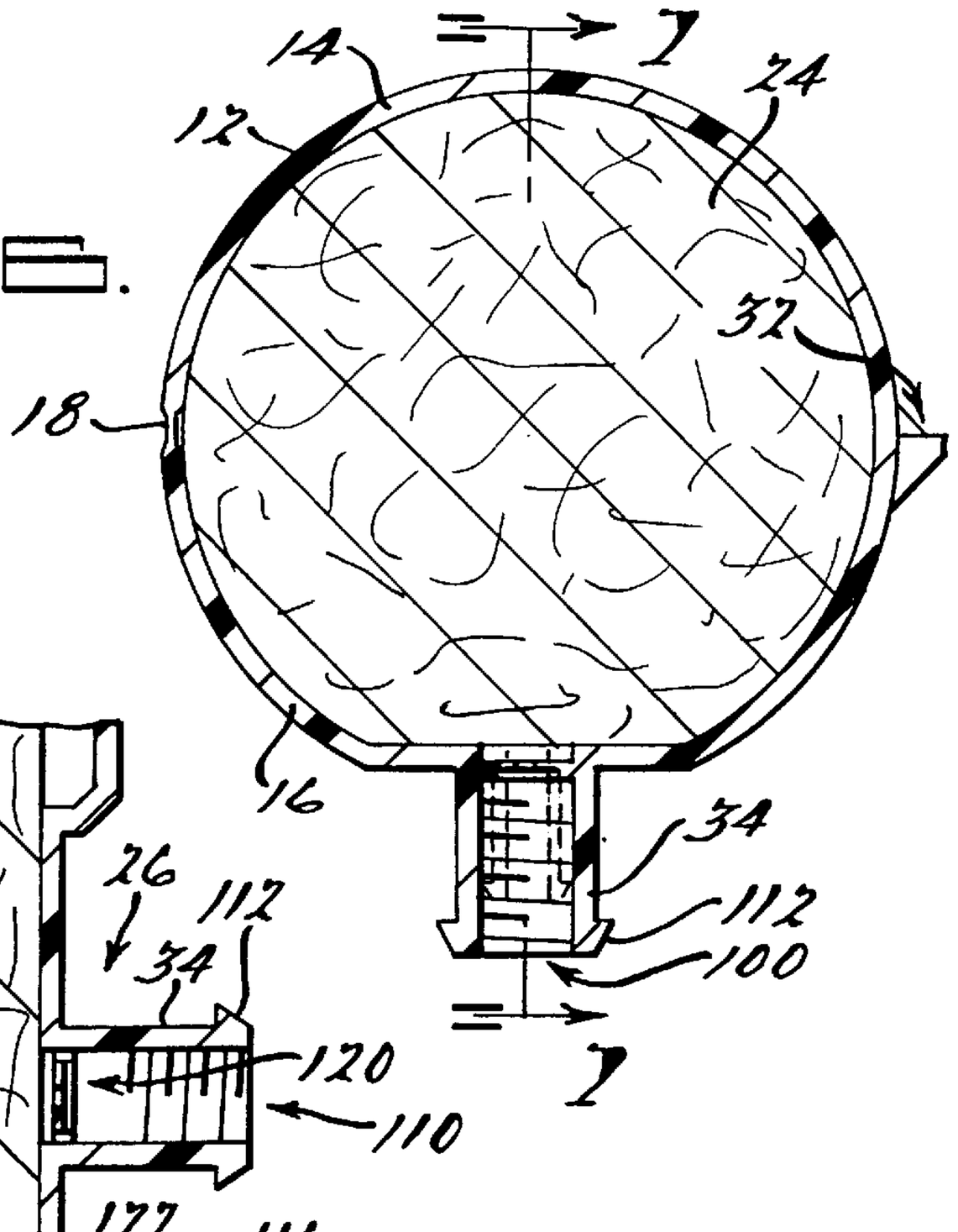

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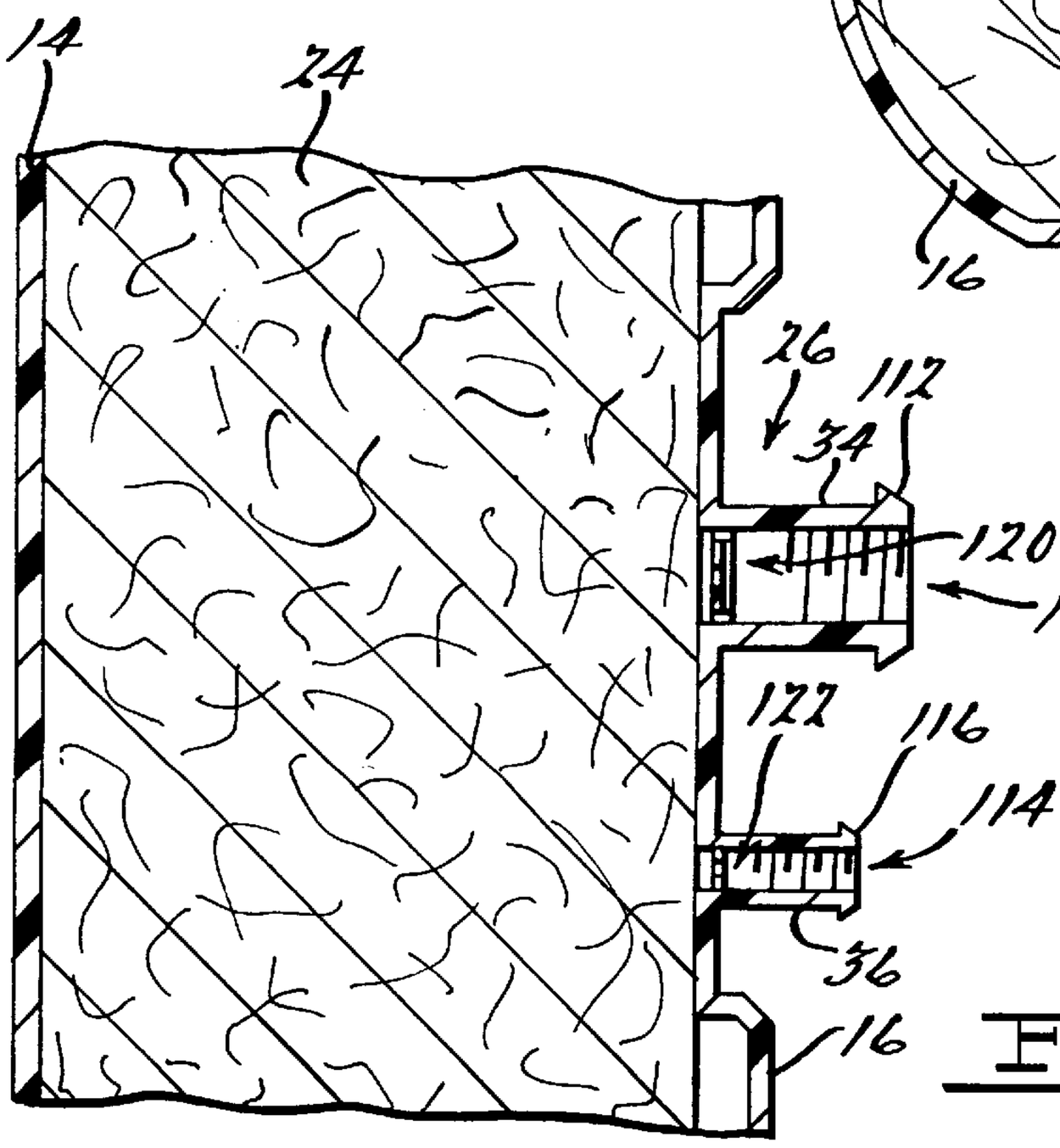

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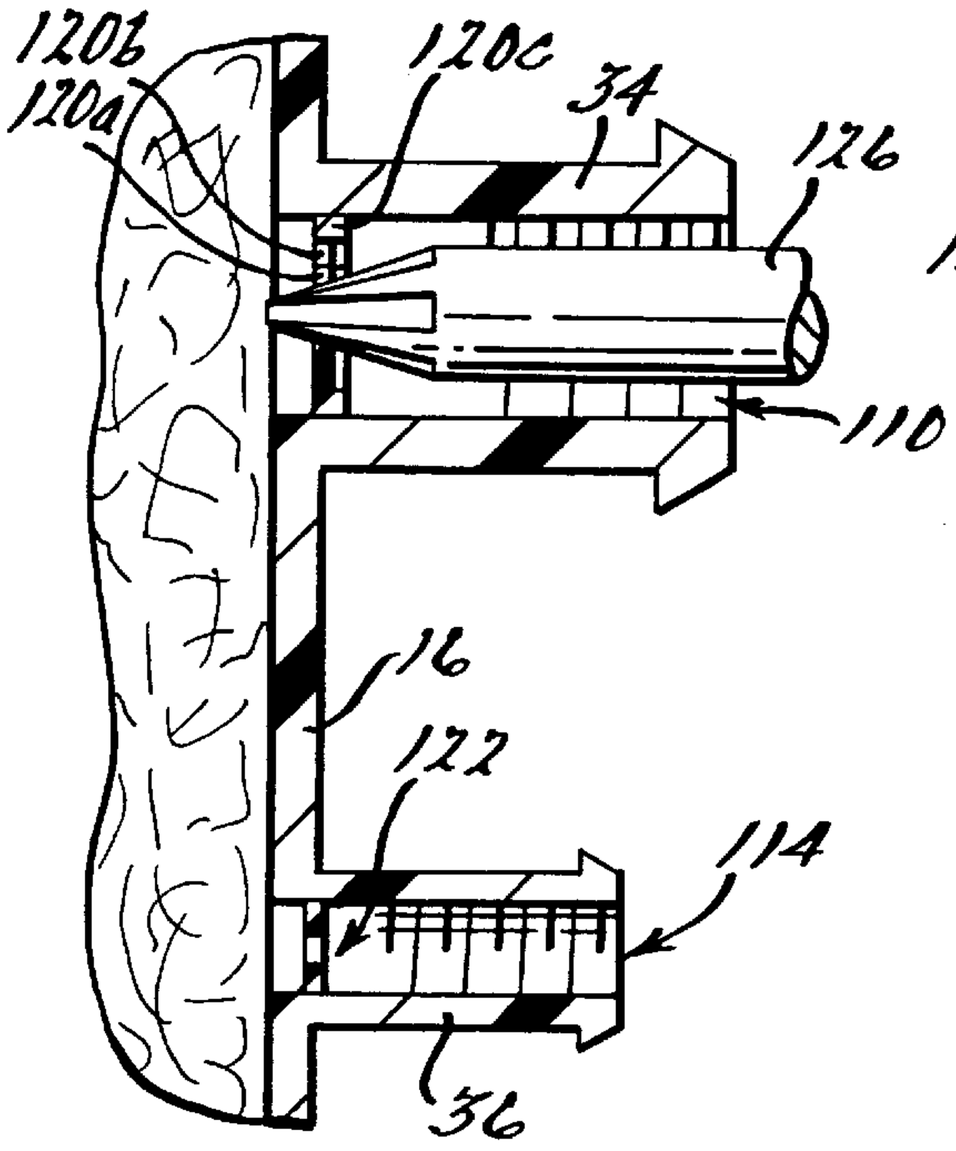
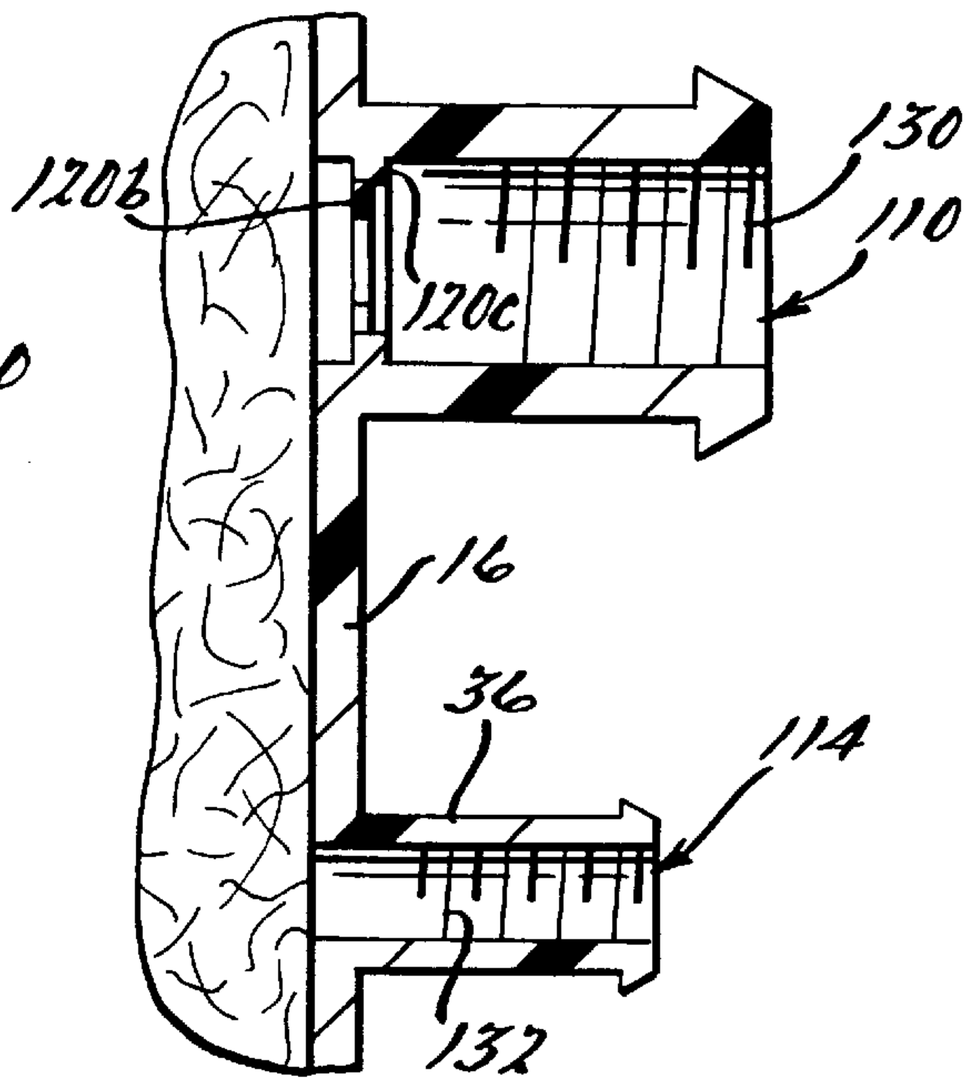


Fig. 8.



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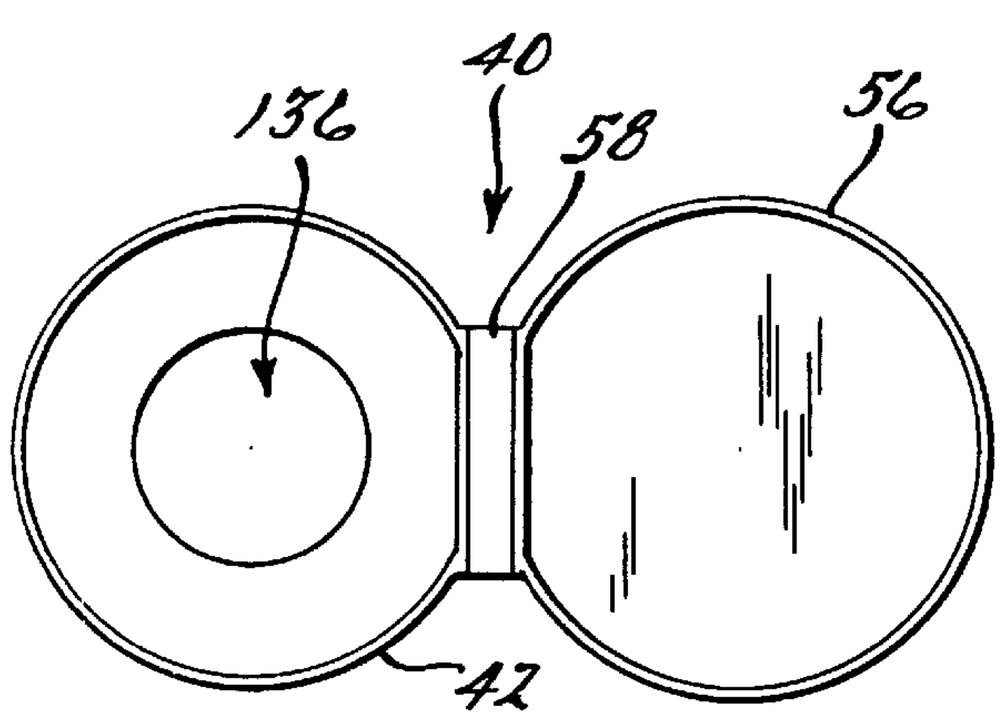

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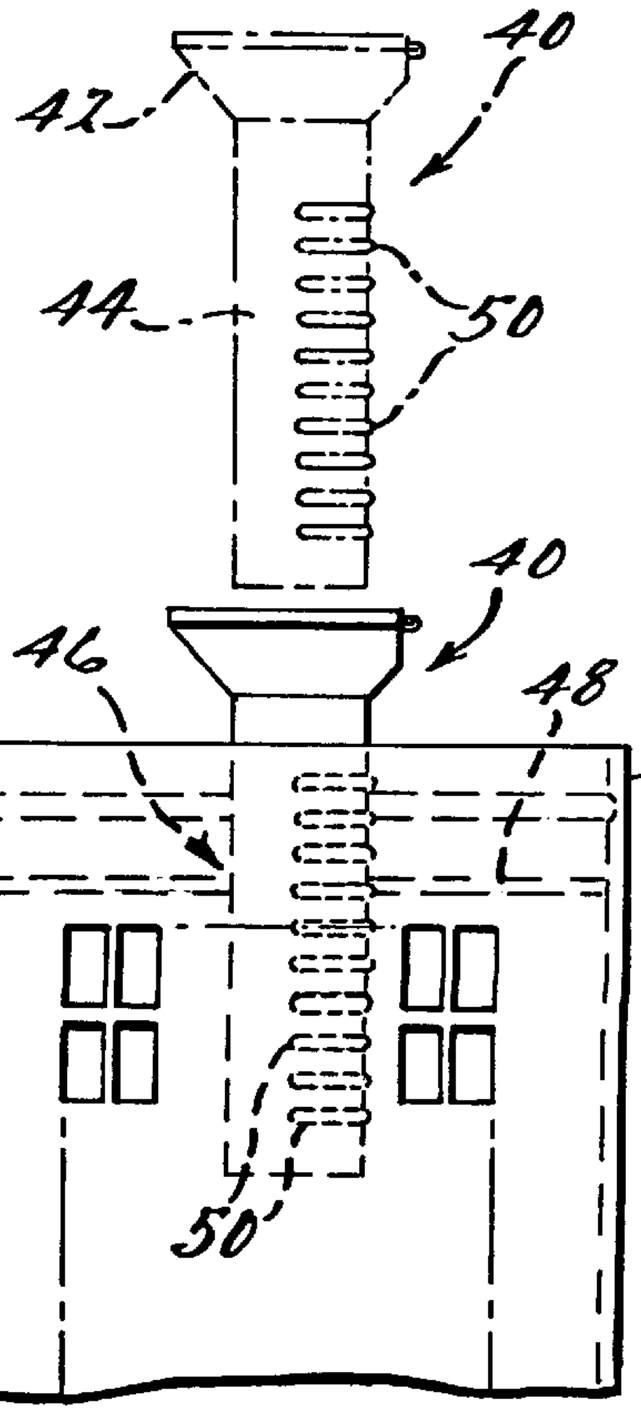

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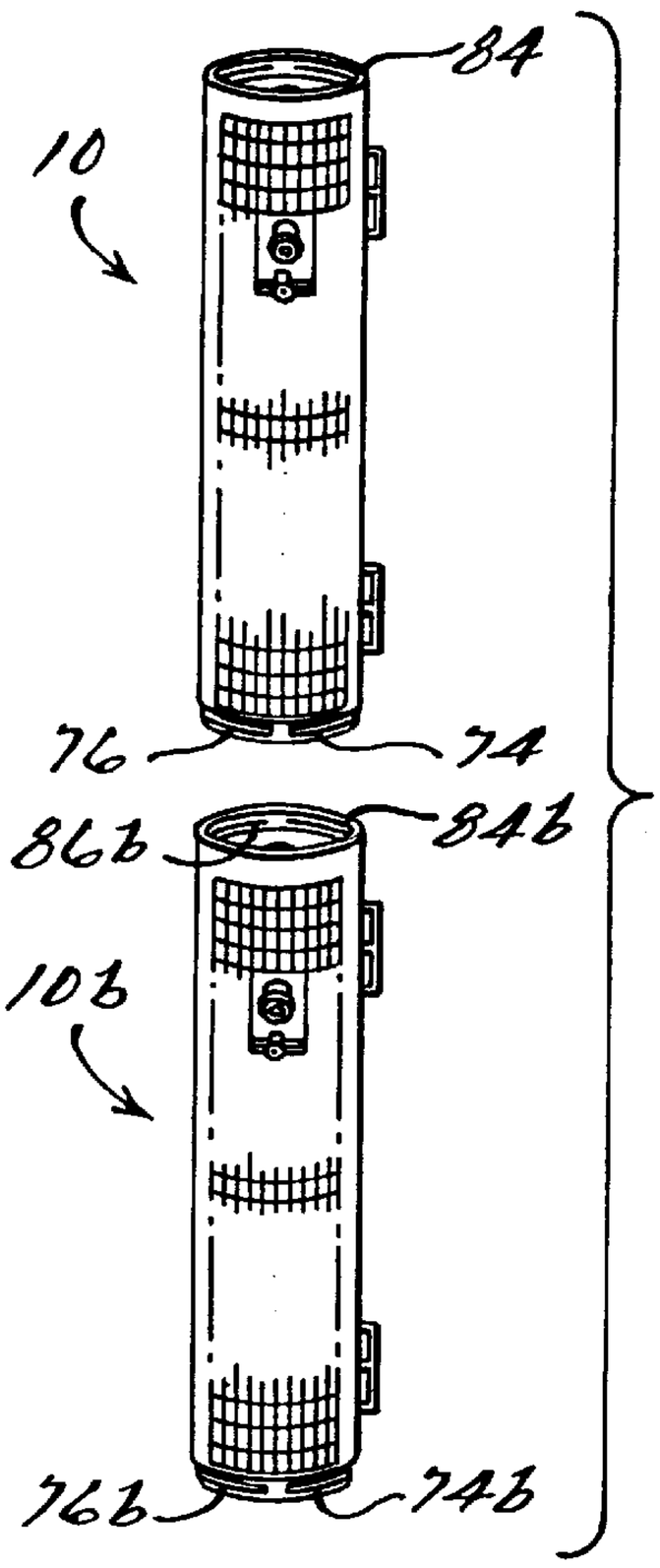

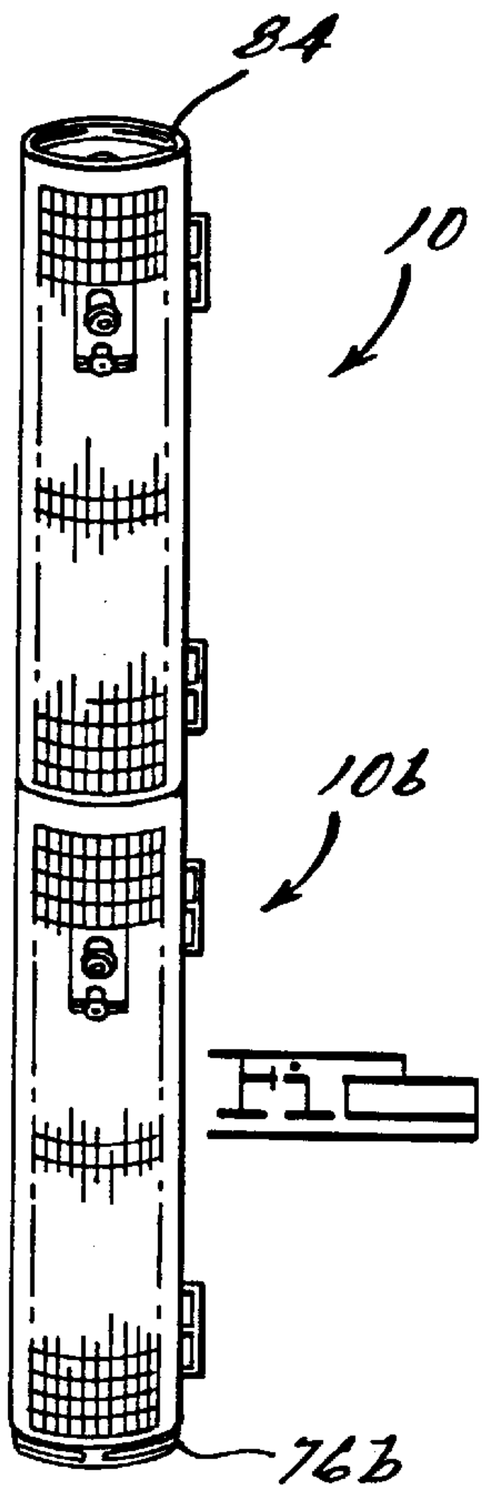

Fig. 13.

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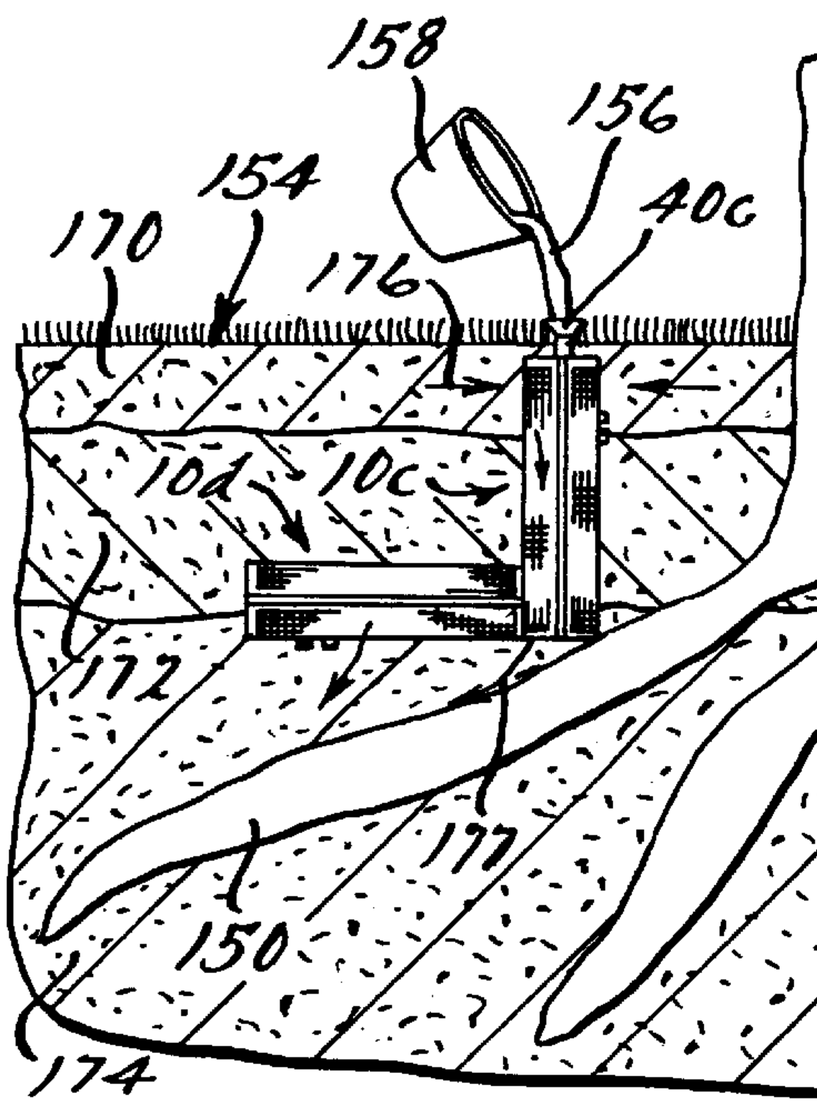

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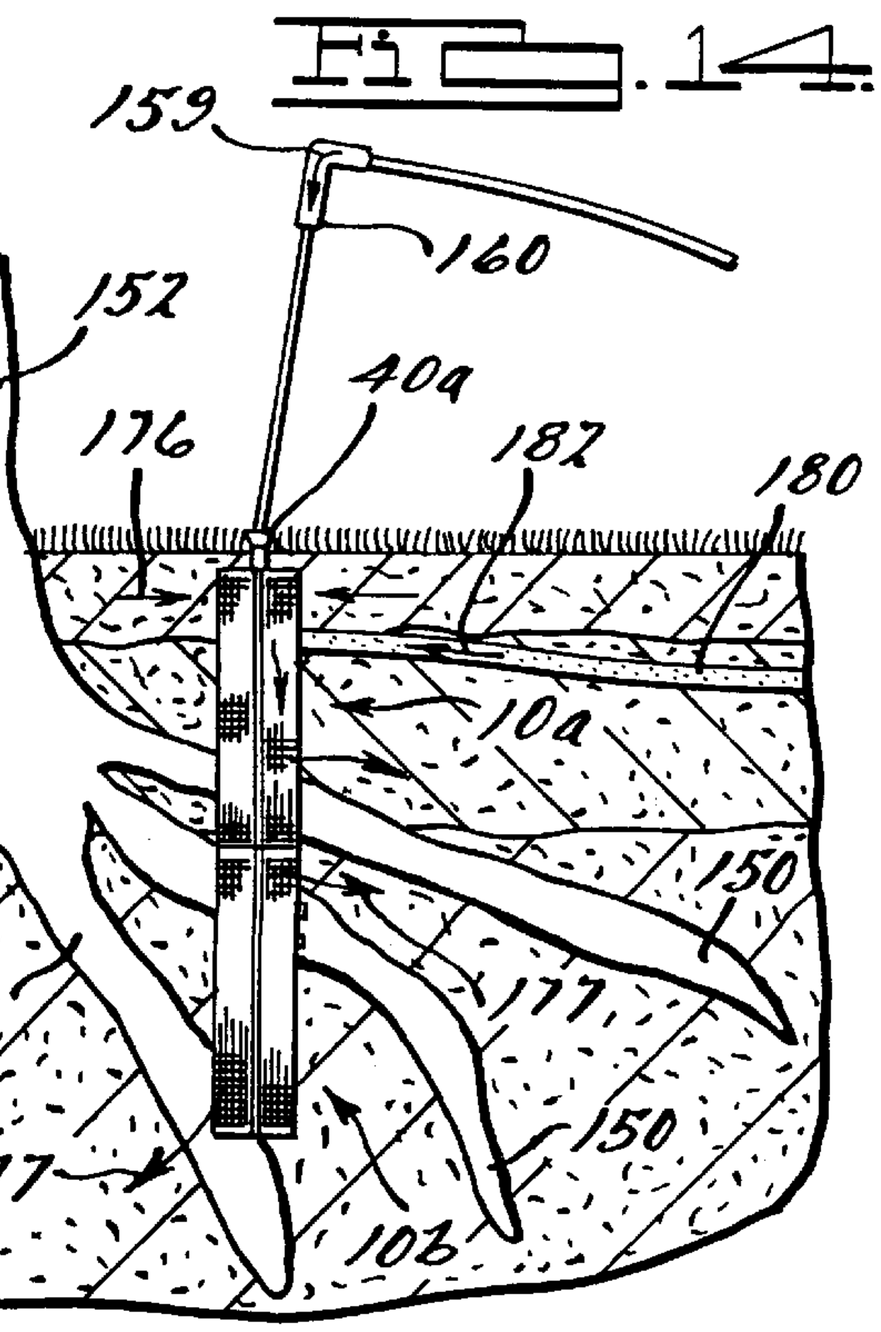

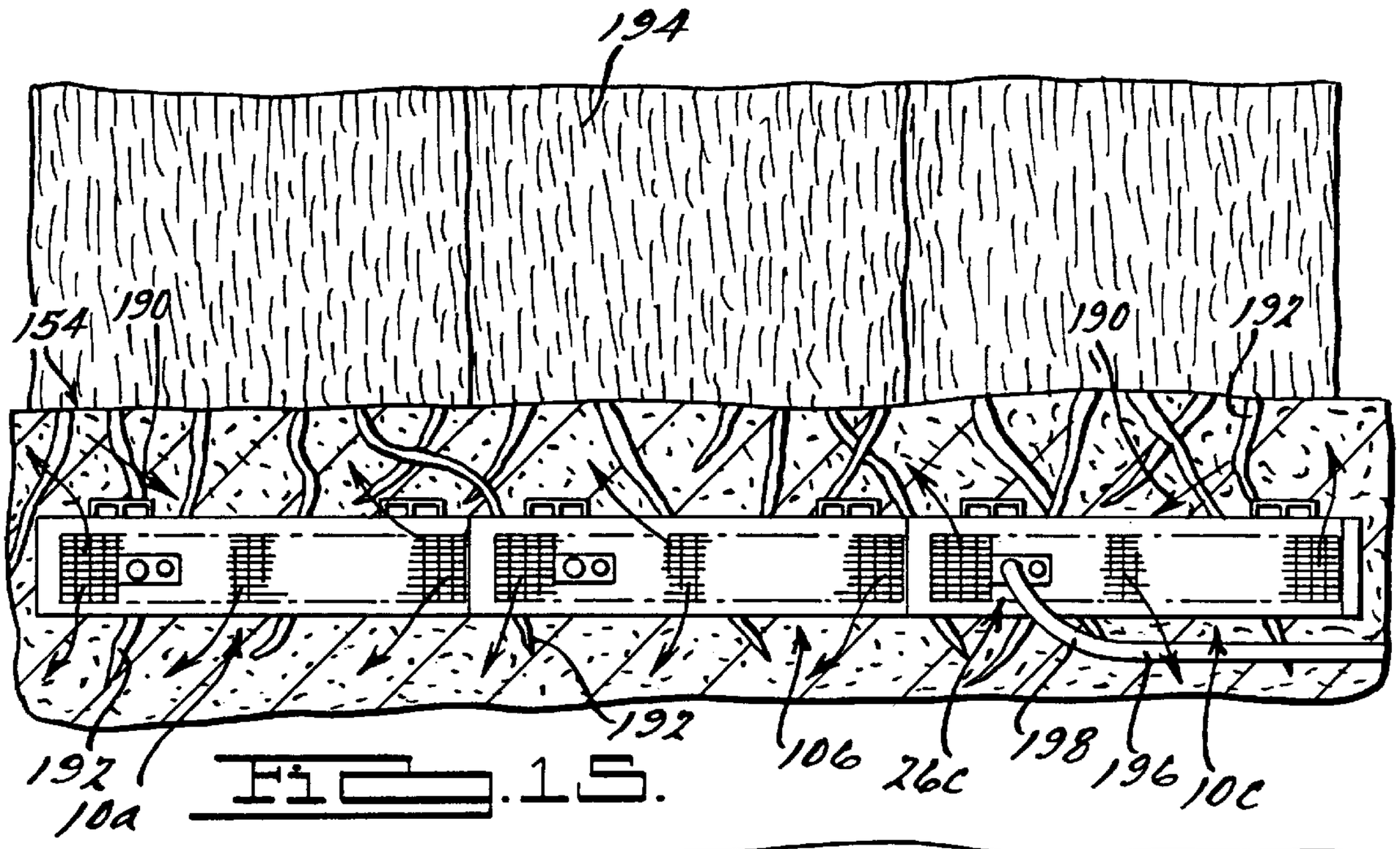
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Fig. 15.

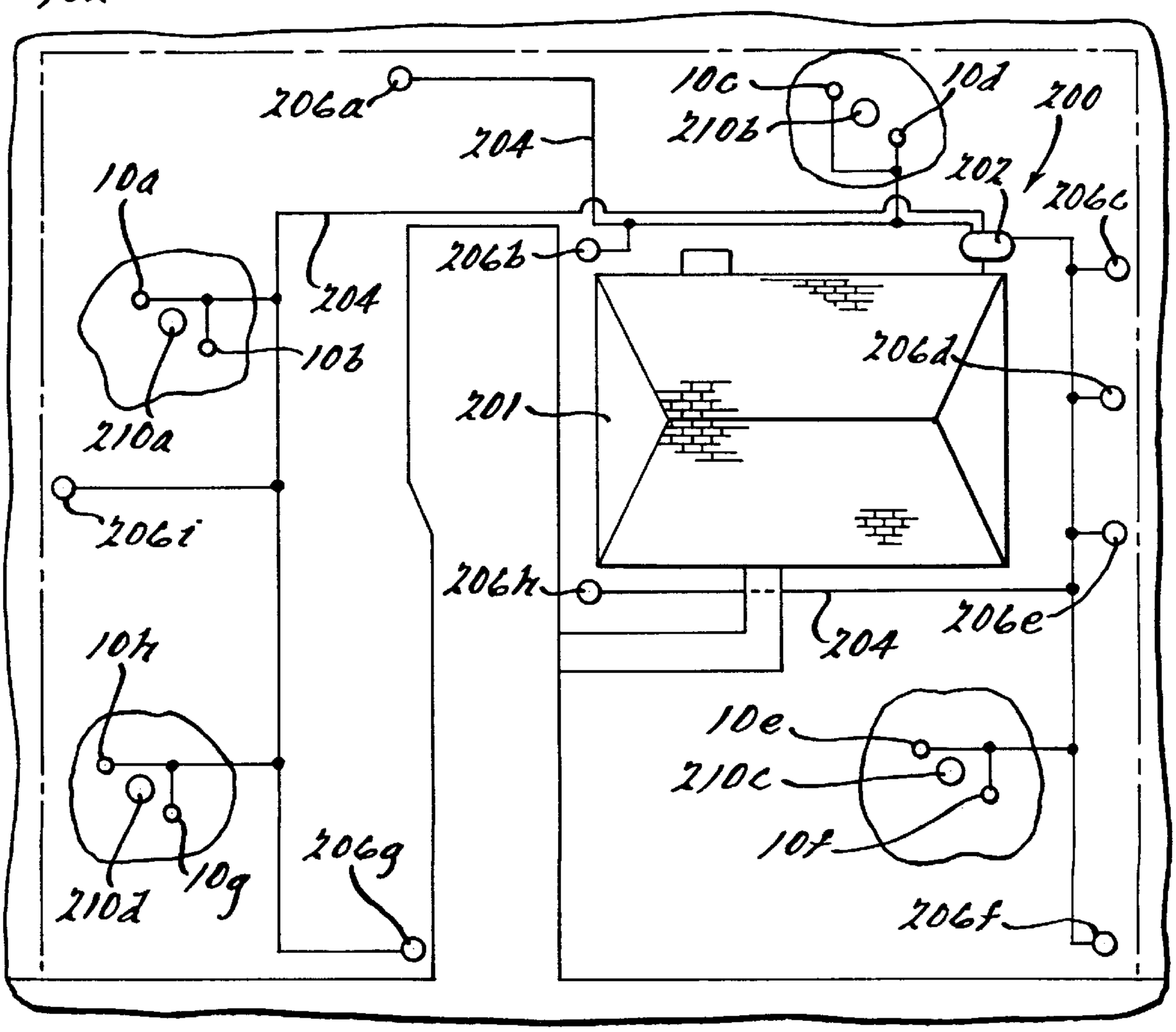
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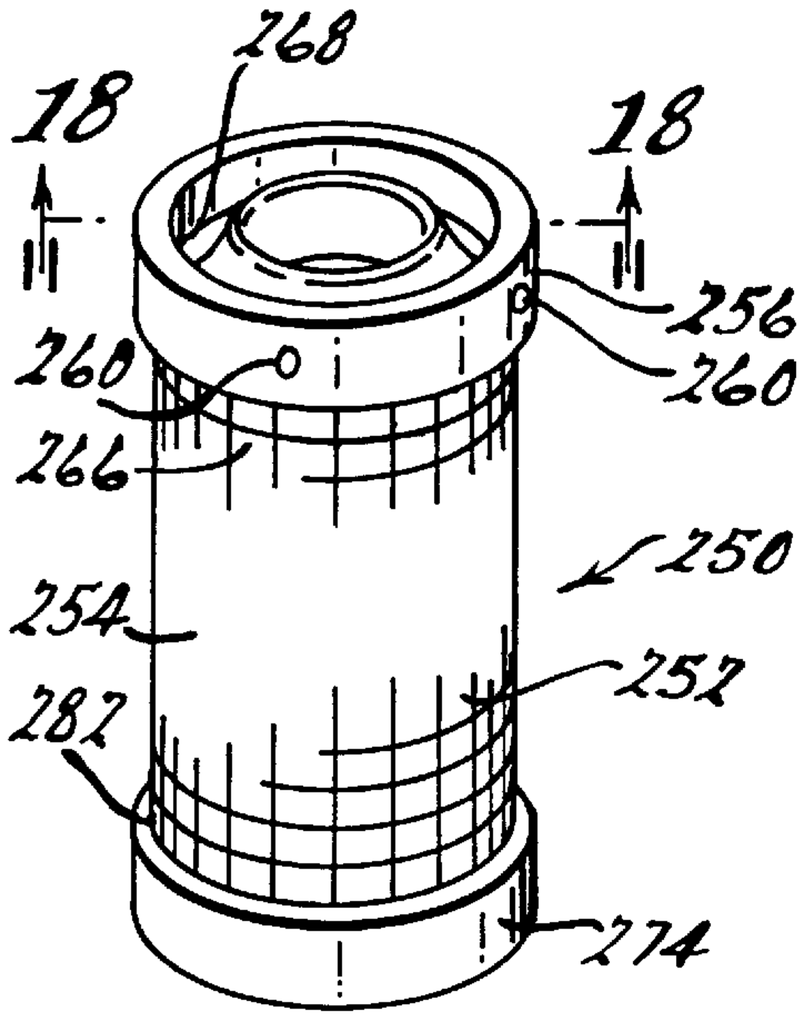
Fig. 16.



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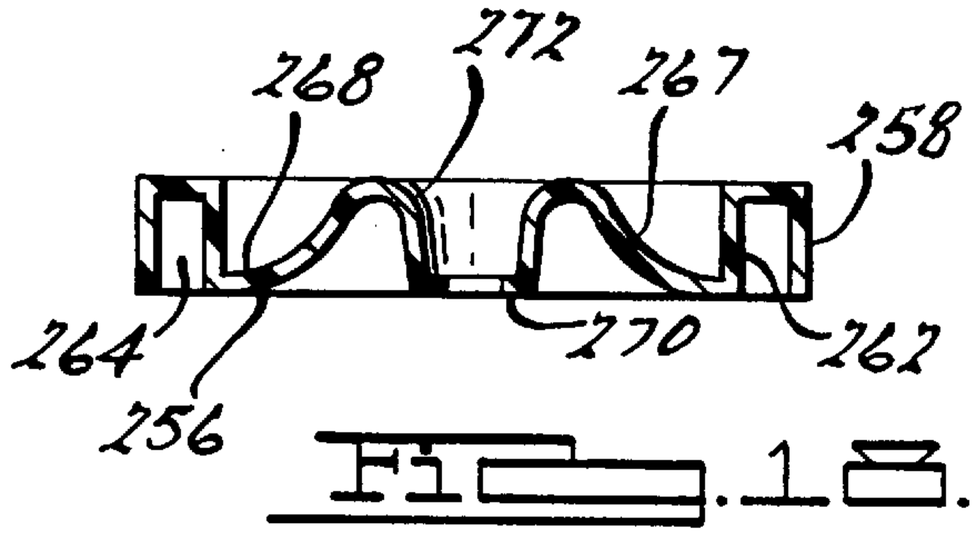

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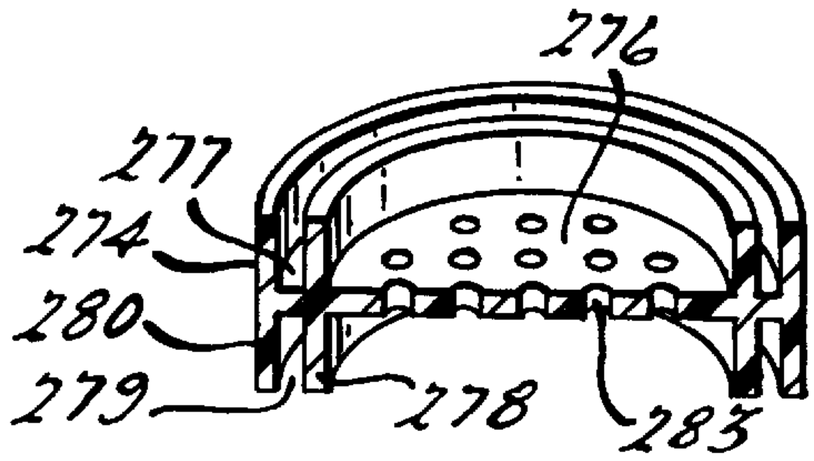

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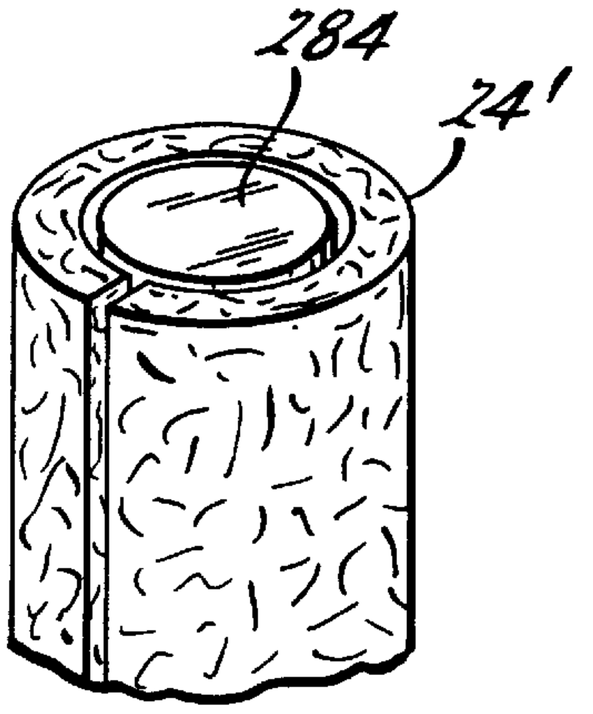

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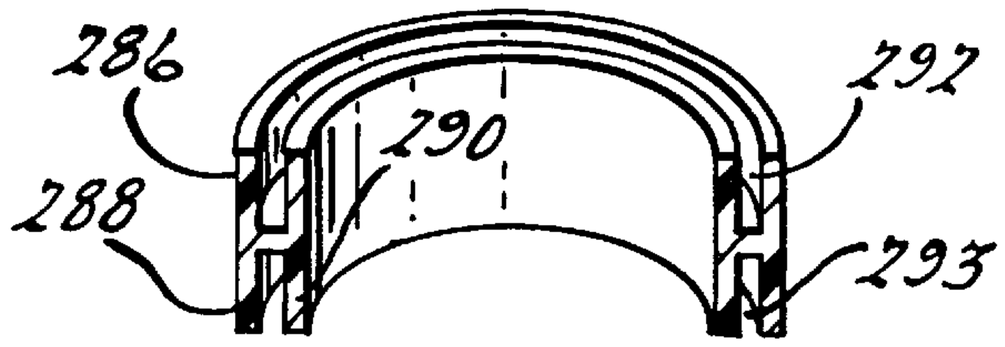
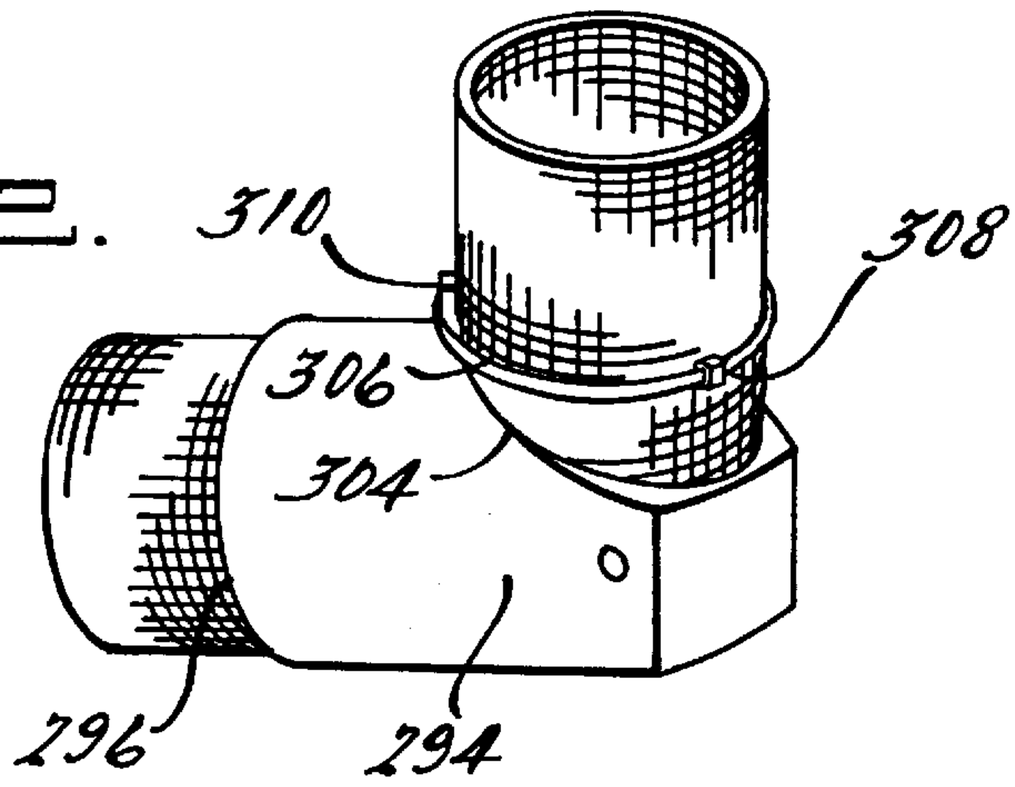
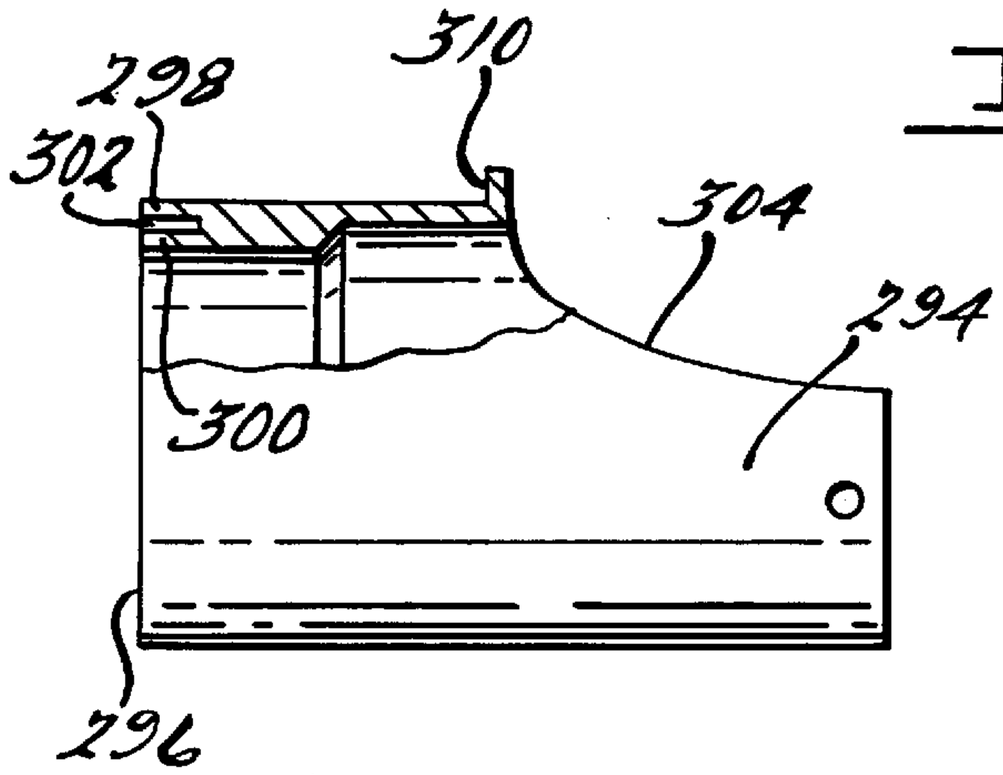


Fig. 21.

Fig. 22.





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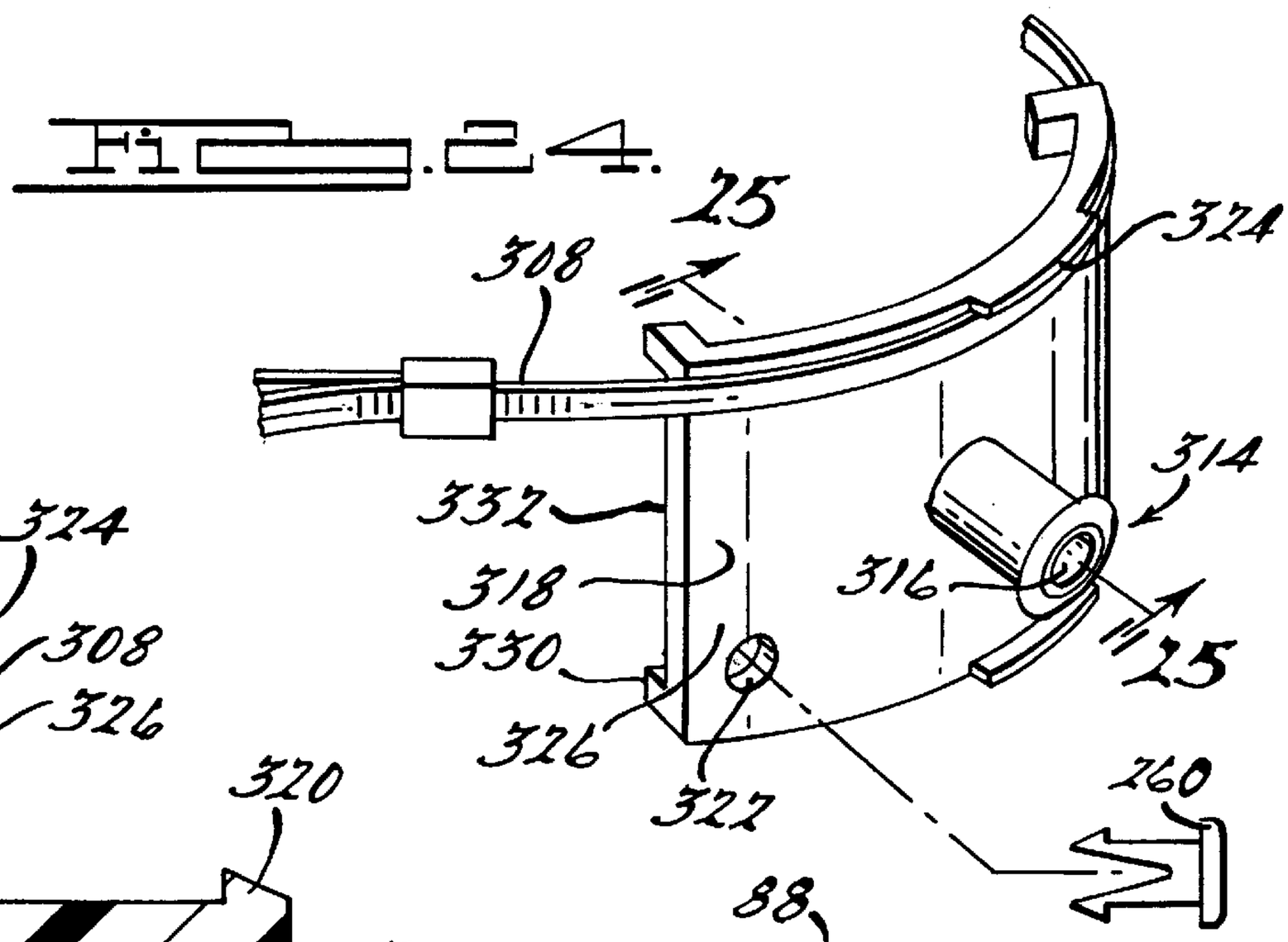

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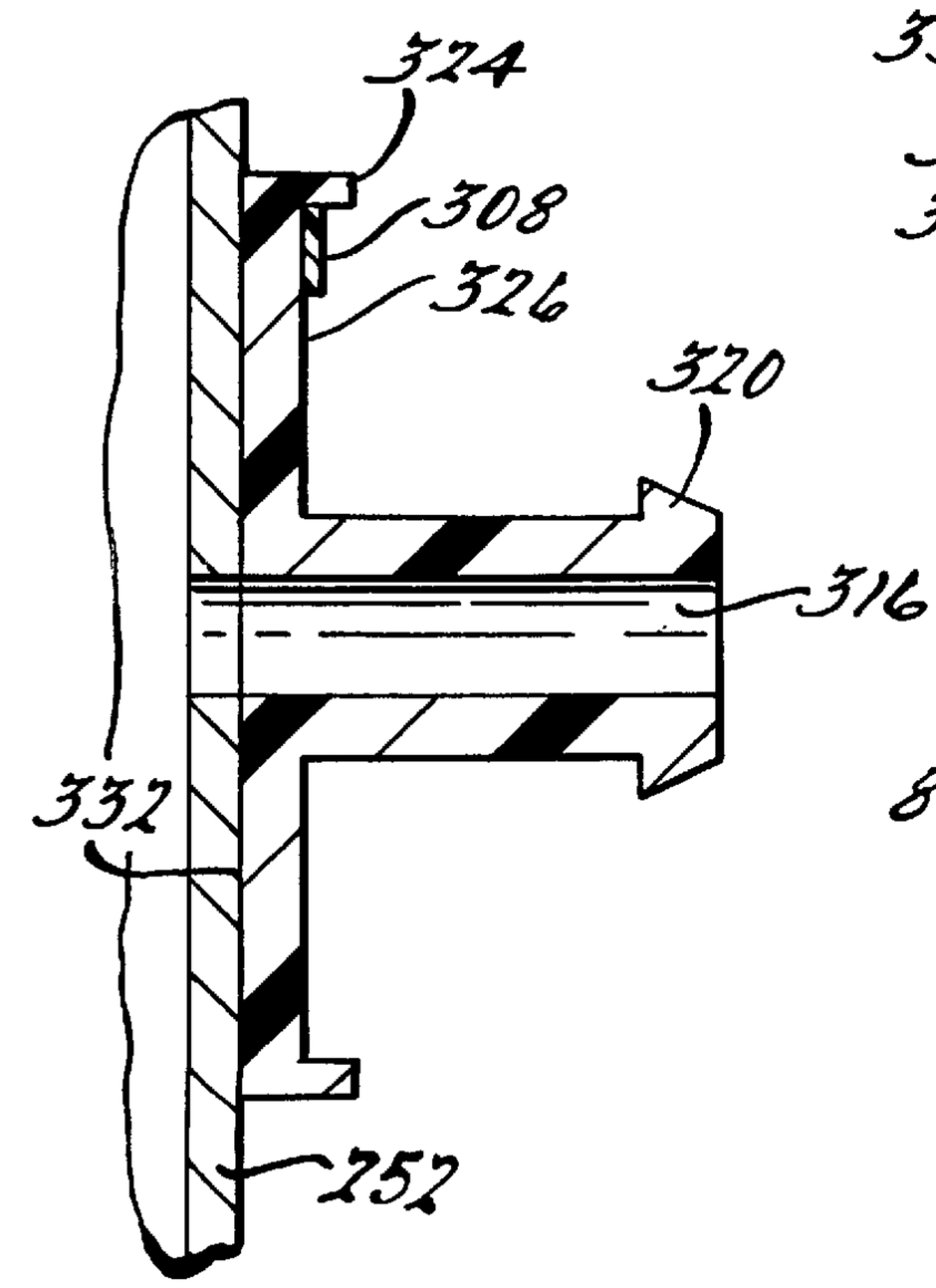

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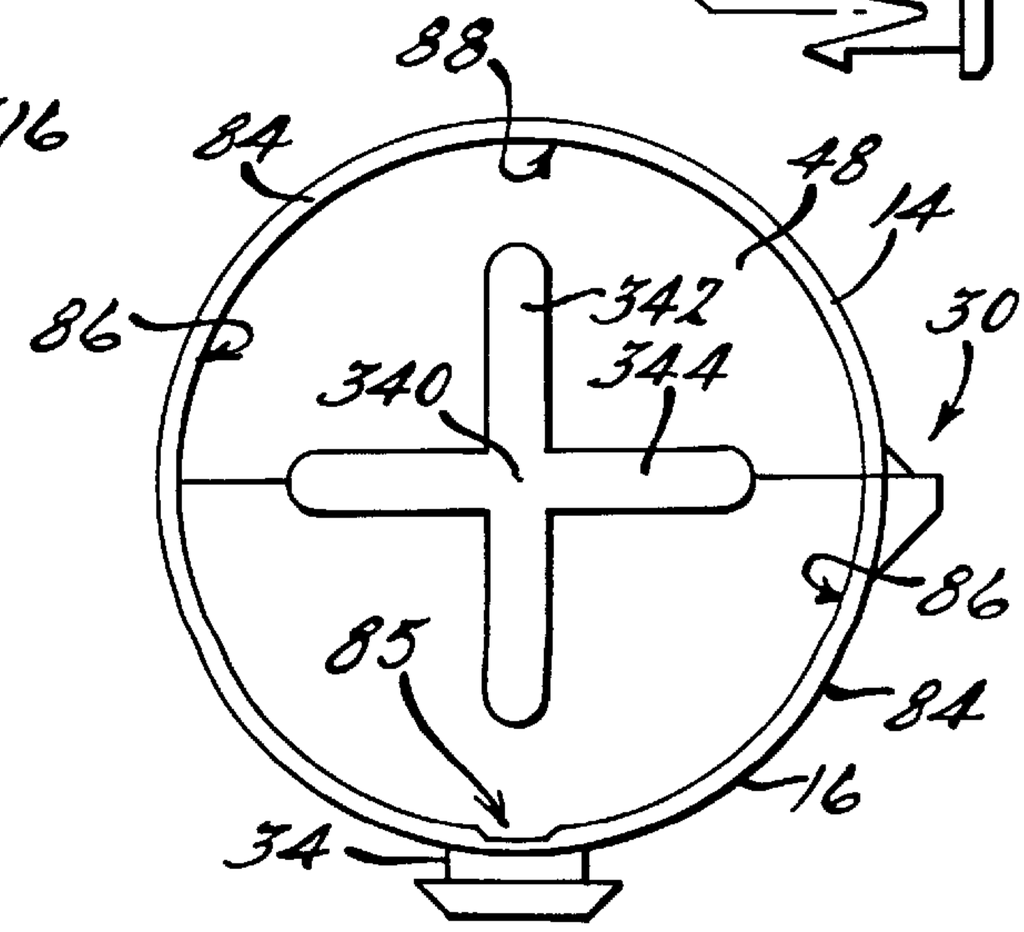

Fig. 26.

SUBTERRANEAN WATER COLLECTION AND DELIVERY DEVICE AND SYSTEM

CROSS REFERENCE TO RELATED APPLICATION

This application is a continuation-in-part of related application Ser. No.: 08/687,634, filed on Jul. 26, 1996 now U.S. Pat. No. 5,795,100.

BACKGROUND OF THE INVENTION

1. Technical Field

This invention relates to plant irrigation, oxygenation and feeding devices and feeding systems and, more particularly, to a subterranean water collection and delivery device and system for irrigating, oxygenating and feeding plants.

2. Discussion of the Related Art

Regardless of whether a tree, bush, or shrub, i.e. plants in general, are planted properly or improperly, a potentially serious problem exists of how such plants receive water and oxygen from above ground level down to their roots where it is needed. Likewise, naturally flowing surface and subsurface ground water often is inhibited from traveling down to various depths where plants' roots have migrated because of varying soil conditions. Immediately after planting, there is less of a problem because the soil surrounding the newly planted plants is loose allowing surface and subsurface ground water and air to freely reach the plants' roots. However, after approximately two weeks, this soil will begin to become compacted and the surface and subsurface ground water and air may be inhibited from traveling freely through the soil to the roots as needed. In the situation where a single plant has been planted, the planter can leave a water hose running for days or weeks in the proximity of the plant and eventually some of the water will reach the roots, but if more than one plant is involved, the watering schedule becomes more critical. For example, a manually placed above ground sprinkler may be left running with a low flow rate for days or weeks. The same is true with commonly employed automatic underground sprinkler systems that water a given area periodically for a predetermined amount of time. However, such water schedules often provide only a fraction of the water necessary for the survival and on going growth of many types of plants. Additionally, in many planting areas where irrigation is not available and the soil conditions do not freely permit the penetration of water to depths commonly associated with the roots of many types of plants, such plants may refuse to grow, may be stunted or wilted, or may die from a lack of needed water and/or nutrients.

Unfortunately, regular surface watering often does not freely penetrate through the ground down to the roots of many plants, and the majority of the water runs past such plants due to soil strata densities. Also, the use of a slow running water hose is a wasteful and risky method of watering plants because running many gallons, sometimes hundreds of gallons, of water in a small area over days will often cause the water to travel in the proximity just below the ground surface on dense soil strata and migrate far away from the plants' deeper roots where it is needed. Surface watering may also enhance the possibility of non-point source pollution which occurs when pollutants are carried away from the plant by water and are deposited into rivers, lakes, coastal waters or ground water.

It is therefore desirable to provide a subterranean water collection and delivery device for efficiently routing natural surface water, naturally flowing subterranean water and

nutrients and oxygen to a plant's roots which may extend a distance below ground level where the ground water and air does not freely migrate.

More particularly, it is desirable to provide a subterranean water and air collection and delivery device which is simply buried at a predetermined depth below ground level and in close proximity to the roots of a plant, typically near the drip line, for providing ingress and egress for surrounding ground water and air at various depths where the plant's roots are located.

It is further desirable to provide a subterranean plant root water and air collection and delivery device that delivers water, air and external substances from above ground level and collects and redirects naturally flowing subterranean water and air to a plant's roots and is easily integrated into an underground irrigation system.

SUMMARY OF THE INVENTION

In accordance with the teachings of the present invention, a subterranean plant root water and air collection and delivery device for facilitating the delivery of water, air and nutrients to the roots of a plant at various levels below ground is disclosed.

In accordance with the teachings of one embodiment of the present invention, the subterranean plant root water and air collection and delivery device includes an enclosure member including a plurality of apertures with an interior volume within which surrounding subterranean ground water and air is collected and naturally redispersed. A porous insert member is located within the interior volume of the enclosure member and substantially occupies the entire interior volume for facilitating collection and delivery of the ground water and air through to the apertures to the root areas of at least one plant. The insert member also substantially prevents surrounding ground material from entering the interior volume of the enclosure member. The enclosure member is buried at a predetermined depth in close proximity to the roots and the drip line of at least one plant such that the plurality of apertures provide ingress and egress for the surrounding ground water and air to and from within the interior volume for efficiently delivering the water and air to the roots of at least one plant.

In accordance with a preferred embodiment, the enclosure member is formed from plastic and includes at least one nipple member extending outwardly from its side surface for engaging a pressurized water and nutrient delivery member which delivers pressurized water and nutrients to its interior volume and ultimately to the roots of the plant.

In accordance with another preferred embodiment, the device includes a funnel member having an upper and a lower portion insertable within an aperture in a top surface of the plastic enclosure member. The funnel member includes a height adjusting mechanism for extending the upper portion of the funnel member at different heights from the top surface of the plastic enclosure member and above ground level for funneling external substances to the interior volume of the enclosure member and ultimately to the roots of the plant.

In accordance with an alternate preferred embodiment, the device is formed of an annular (e.g., cylindrical, hexagonal or square) plastic body having apertures substantially about its entire surface. A top cap, and a bottom cap or a through connector, are fastened to the first end and second end of the body after a porous insert is positioned within the interior volume thereover. Nipple members may be fastened to the body of the present embodiment to provide for attachment to an irrigation system.

BRIEF DESCRIPTION OF THE DRAWINGS

The various advantages of the present invention will become apparent to those skilled in the art after reading the following specification and by reference to the drawings in which:

FIG. **1** is a plan view of an opened subterranean water and air collection and delivery device along with a porous insert member in accordance with the teachings of the present invention;

FIG. **2** is a view of the subterranean plant root water and air collection and delivery device in a closed position with the porous insert member located therein along with a funnel member in accordance with the teachings of the present invention;

FIG. **3** is a view, along Line **3—3** of FIG. **2**, of the bottom of the subterranean plant root water and air collection and delivery device in accordance with the teachings of the present invention;

FIG. **4** is a view, along Line **4—4** of FIG. **2**, of the top of the subterranean plant root water and air collection and delivery device in accordance with the teachings of the present invention;

FIG. **5** is a partial view of a closed latch assembly of the subterranean plant root water and air collection and delivery device in accordance with the present invention;

FIG. **6** is a cross-sectional view, along Line **6—6** of FIG. **2**, of the subterranean plant root water and air collection and delivery device in accordance with the teachings of the present invention;

FIG. **7** is a cross-sectional view, along Line **7—7** of FIG. **6**, of the subterranean plant root water and air collection and delivery device in accordance with the present invention;

FIG. **8** is a cut-away view illustrating the use of a tool for individually removing concentric punch-out members of a coupling assembly in accordance with the teachings of the present invention;

FIG. **9** is the same cut-away view as in FIG. **8** after some of the concentric punch-out members have been removed in accordance with the teachings of the present invention;

FIG. **10** is a view, along Line **10—10** of FIG. **2**, of the funnel member in accordance with the teachings of the present invention;

FIG. **11** is a view illustrating the manner in which the funnel member is inserted and locked in position within the subterranean plant root water and air collection and delivery device in accordance with the teachings of the present invention;

FIG. **12** is a view of two identical subterranean plant root water and air collection and delivery devices prior to being coupled to one another in accordance with the teachings of the present invention;

FIG. **13** is a view of the two subterranean water and air collection and delivery devices after being coupled to one another in accordance with the teachings of the present invention;

FIG. **14** illustrates a stand alone and a coupled pair of subterranean plant root water and air collection and delivery devices buried in substantially vertical manners in close proximity of the roots of a plant for delivering collected natural air or ground water, supplied pressurized water and nutrients to the roots at varying depths below ground level in accordance with the teachings of the present invention;

FIG. **15** illustrates three subterranean plant root water and air collection and delivery devices coupled to one another and buried in a substantially horizontal manner for delivering collected natural air or ground water, supplied pressurized water and nutrients to the roots of a plant at a substantially constant depth in accordance with the teachings of the present invention; and

FIG. **16** is a schematic illustration of an underground irrigation system including a plurality of the subterranean plant root water and air collection and delivery devices integrated with a pressurized water supply in accordance with the teachings of the present invention;

FIG. **17** is a perspective view of an alternate embodiment of the subterranean plant root water and air collection device made in accordance with the teachings of the present invention;

FIG. **18** is a sectional view of a top cap taken along line **18—18** in FIG. **17**;

FIG. **19** is a sectional view of an alternate bottom cap made in accordance with the teachings of the present invention;

FIG. **20** is a perspective view of an alternate insert member made in accordance with the teachings of the present invention;

FIG. **21** is a sectional view of a through connector made in accordance with the teachings of the present invention;

FIG. **22** is an angle connector utilized in the present invention;

FIG. **23** is a partial sectional view of the angle connector from FIG. **22**;

FIG. **24** is a perspective view of a nipple member made in accordance with the teachings of the present invention;

FIG. **25** is a sectional view taken along line **25—25** in FIG. **24**; and

FIG. **26** is a top view of an alternate embodiment top cap member.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The following description of the preferred embodiments is merely exemplary in nature and is in no way intended to limit the invention or its application or uses.

The present invention is particularly concerned with providing a subterranean plant root water and air collection and delivery device that efficiently collects and redirects air, naturally flowing surface water, subterranean water, manually supplied water, and/or water and nutrients supplied by an irrigation system to the roots of trees, bushes, or shrubs, all commonly referred to as plants, for improving the growth and health of such plants. It is important that most types of plants receive an appropriate amount of water, air and nutrients such as fertilizer and phosphates, especially during the first several years after planting, for facilitating the maturity of their root structures. The present invention is specifically designed for integration into an underground irrigation system and/or may be used as a complete stand-alone system where underground irrigation is not available. Additionally, the present invention is particularly concerned with providing a device which provides for manual above-ground application of air, water and/or fertilizers and efficiently delivers these substances to the root structures of all types of plants. The present invention provides flexibility for many applications in that it may be installed at the time of new planting or may be used in conjunction with an existing plant.

Turning to FIG. **1**, an opened subterranean plant root water and air collection and delivery device **10** in accor-

dance with the present invention is shown. The device **10** includes a plastic enclosure member **12** that may be manufactured in an open position as shown (for convenience of shipping) or closed during use in conjunction with irrigating plants. The enclosure member **12** includes a first half portion **14** and a second half portion **16** that are coupled to one another via a hinge portion **18**. The enclosure member **12** has a clamshell-like shape when opened and a substantially cylindrical shape when closed. The enclosure member **12** includes a plurality of apertures **22** which are formed substantially throughout the entire surface area of the enclosure member **12**. As will be discussed in detail below, when the device **10** is buried next to a plant, the apertures **22** provide ingress and egress for water, air and nutrients to and from within the enclosure member **12** and redirects these substances to the plant's root area throughout the length of the enclosure member **12**. The enclosure member **12** may be formed from a rigid or a flexible material that is lightweight and resistant to corrosion from exposure to natural elements. However, the enclosure member **12** may be formed from a flexible resilient plastic material for specific applications. Therefore, it is presently preferred to manufacture the enclosure member **12** by way of an extrusion process. The extrusion process also facilitates the formation of the apertures **22** during production. Polypropolene is the preferred material for the enclosure member **12** if an extrusion process is employed. Additionally, starch may be mixed into the polypropolene to enhance biodegradability.

The device **10** includes a separate porous insert member **24** which is insertable within and substantially occupies an interior volume between the first and second half portions **14** and **16**. The enclosure member **12** is designed for economy since the device is to be left in the ground indefinitely. Thus, it is typically the insert member **24** which provides structural support for the enclosure member **12**. Preferably, the porous insert member **24** is made from an open cell foam or structural non-woven material that provides structural reinforcement of the enclosure member **12** and which may be replaced if necessary. In an alternate embodiment of the present invention, the porous insert member **24** is omitted. In this embodiment, the enclosure member **12** possesses sufficient rigidity due to the extrusion process of manufacturing and the size of the apertures **22** to be self-standing. As will be discussed in detail below, when the device **10** is buried in the ground, the porous insert member **24** facilitates the collection and delivery of water, air and nutrients to the root areas of a plant located in the close proximity to the device **10** while substantially preventing surrounding ground material from entering the interior volume of the enclosure member **12**. The enclosure member **12** further includes an integral water coupling assembly **26** for coupling the device **10** to an underground irrigation system that supplies pressurized water and nutrients to the device **10** for rerouting to the roots of a plant. A packaging aperture **27** is formed in the first half portion **14** and is configured to receive a coupling assembly of another device stacked thereon in the opposite direction. The aperture **27** allows numerous devices to be stacked upon one another in alternating direction for purposes of mass storage and shipping.

Turning to FIG. **2**, the device **10** is shown after being closed with the porous insert member **24** located within the interior volume of the enclosure member **12**. In order to maintain the closed position as shown, the enclosure member **12** includes a first latch assembly **30** and a second latch assembly **32**. The latch assemblies **30** and **32** are identical and will be described in detail below in conjunction with latch assembly **32**.

The coupling assembly **26** includes a first nipple member **34** having a first diameter and a second nipple member **36** having a second smaller diameter. The differing diameters allow the device **10** to be coupled to irrigation systems employing water delivery members having various sizes. The specifics of the coupling assembly **26** will be described in detail below in conjunction with FIGS. **6–9**.

The device **10** further includes a funnel member **40** having an upper tapered portion **42** and a lower portion **44**. The lower portion **44** is configured for insertion within an aperture **46** located in a top surface **48** of the enclosure member **12**. As will be discussed in conjunction with FIG. **14**, the funnel member **40** provides a convenient means for manually funneling water, air and/or nutrients to the interior volume of the enclosure member **12** and ultimately to the roots of a plant when the device **10** is buried below the ground. A plurality of raised tab members **50** are formed along the lower portion **44** for engaging the top surface **48** about the edge of the aperture **46**. As will be discussed in detail below in conjunction with FIG. **11**, the raised tab members **50** frictionally engage the top surface **48** and enable the funnel member **40** to be extended different heights from the top surface **48** of the enclosure member **12** for different applications. A cap member **56** is coupled to the upper portion **42** by a flexible hinge **58** for capping the upper portion **42** when the funnel **40** is not in use. Preferably, the funnel member **40** is formed from a plastic material. An advantage with the use of plastic materials are their resistance to decay from exposure to the natural elements which extend the useful life of the device **10**. It will be readily appreciated that the device will work with indentations in the funnel in the place of tabs **50** and tabs extending radially inwardly from the aperture **46** in the top surface **48**. Further, the skilled artisan will recognize that although employment of the funnel member **40** is preferred, the device **10** may be used in its absence simply by leaving the upper portion exposed above ground.

Turning to FIG. **3**, a view along Line **3—3** of a bottom surface **70** of the enclosure member **12** is shown. In order to increase the flow of water and air to and from within the device **10**, a plurality of apertures **72** are formed throughout the bottom surface **70**. A bottom lip member **74** is formed about the outer periphery of the bottom surface **70** for engaging and coupling the device **10** to a second identical device **10***b*, shown in FIGS. **12** and **13**, for increasing the amount of water and air redirected to a plant. A plurality of rib members **76** are formed about an outer surface **78** of the bottom lip member **74**. A key member **77** is provided for engaging a keyway of the second device **10***b* and for providing relative alignment of the two devices.

Turning to FIG. **4**, a view along Line **4—4** of FIG. **2** of the top surface **48** of the enclosure member **12** is shown. In addition to aperture **46**, a plurality of apertures **82** are formed throughout the top surface **48** for increasing the flow of water and air to and from within the device **10**. A top lip member **84** is formed about the outer periphery of the top surface **48**. A plurality of indentations **86** and a keyway **85** are formed within an inner surface **88** of the top lip member **84**. As with the bottom lip member **74**, the top lip member **84** is configured for engaging a bottom lip member, configured the same as bottom lip member **74**, of another subterranean plant root water and air collection and delivery device. Bottom lip rib members of another like device, configured the same as rib members **76**, are secured within the indentations **86** and a keyway **85** receives a key member, configured like key member **77**, for providing alignment of the device **10** and for restricting relative twisting between

the devices. The top and bottom lip members **74** and **84** of the device **10** allow two other identical subterranean plant root water and air collection and delivery devices to be coupled thereto in a serial fashion for a particular application. As illustrated in FIG. **26**, as an alternative to the aperture **46**, an asterisk-like or cross-shaped opening **340** consisting of a plurality of intersecting slots **342**, **344** may be formed in the top surface **48** for grasping an external substance delivery device such as the lower portion **44** of the funnel member **40** (FIG. **4**) or the end of a hose (not shown).

Turning to FIG. **5**, a partial side view, along Line **5** of FIG. **2**, of the closed second latch assembly **32** is shown. As is best shown in FIG. **1**, the latch assembly **32** includes first and second male latch members **90** and **92** that are formed as part of the first half portion **14** of the enclosure member **12**. The latch assembly **32** further includes a female latch member **94** that is formed as part of the second half portion **16** of the enclosure member **12**. The first and second male latch members **90** and **92** include lip portions **96** and **98** for engaging the female latch member **94** when the device **10** is closed. As shown FIG. **5**, the first and second male latch members **90** and **92** are located within the female latch member **94** and separated by a floating center post member **100**. The post member **100** allows the female latch member **94** to flex for facilitating the closure of the first and second half portions **14** and **16**. As will be apparent, the first latch assembly **30** operates in an identical fashion to further assure that the first and second half portions **14** and **16** are secured to one another.

FIG. **6** is a cross-sectional view, along Line **6—6** of FIG. **2**, showing the porous insert member **24** located within the interior volume of the device **10**. As shown, the porous insert member **24** substantially fills the interior volume of the plastic enclosure member **12**. Also from this view, the first nipple member **34** of the coupling assembly **26** is shown having a central aperture **110** which extends to the interior volume of the enclosure member **12**. The nipple member **34** has a hose barb portion **112** that is configured to receive and secure a pressurized hose member (not shown) which is part of an underground irrigation system.

Turning to FIG. **7**, a cross-sectional view, along Line **7—7** of FIG. **6**, of both the first and second nipple members **34** and **36** is shown. Again, the first nipple member **34** is shown having a larger diameter than the second nipple member **36**. The second nipple member **36** includes a central aperture **114** which extends to the interior volume of the enclosure member **12**. Likewise, the second nipple member **36** includes a hose barb portion **116** for receiving and securing a pressurized hose member having smaller diameter than that used with the first nipple member **34**. The nipple members **34** and **36** provide a passageway for pressurized water to enter the device **10**. In order to vary the flow rate of the water entering the interior volume of the enclosure member **12**, the first nipple member **34** includes a concentric punch-out assembly **120** and the second nipple member **36** includes a concentric punch-out assembly **122**. The concentric punch-out assemblies **120** and **122** respectively define holes with varying diameters that restrict fluid flow and thereby adjust the flow rate of water through the nipple members **34** and **36**.

Turning to FIG. **8**, a tool member **126**, preferably a screw driver, is illustrated being inserted within the opening **110** of the nipple member **34**. From this view, it can be seen that the concentric punch-out assembly **120** include a first member **120***a*, a second member **120***b* and a third member **120***c*. Each of the members **120***a*–**120***c* have varying diameters and are individually removable such that the resulting diameter of the hole defined by the concentric punch-out assembly **120** may be varied. As illustrated, the tool **126** is shown engaging the first concentric punch-out member **120***a* so as to break it away from member **120***b*. As shown in FIG. **9**, the removal of member **120***a* increases the diameter of the initial hole defined by the assembly **120** and therefore the flow rate of water into the device **10**. Likewise, the tool **126** is used to adjust the diameter of the hole defined by the assembly **122**. It should be noted that assemblies **120** and **122** may be modified to include more or less punch-out members for adjusting the flow rates therethrough.

As best shown in FIG. **9**, the nipple member **34** includes a threaded inner surface **130**, and the nipple member **36** includes a threaded inner surface **132**. The threaded inner surfaces **130** and **132** are provided for engaging and securing threaded water pipe members (not shown) that are coupled to an underground irrigation system for providing pressurized water to the enclosure member **12**.

Turning to FIG. **10**, a view illustrating the funnel member **40** is shown. The funnel member **40** includes a central aperture **136** through which water, air and/or nutrients are manually funneled to the interior volume of the enclosure member **12**.

Turning to FIG. **11**, the funnel member **40** is shown being inserted with the aperture **46** in the top surface **48** of the enclosure member **12**. As shown, the raised tabs **50** frictionally engage the top surface **48** of the enclosure member such that the upper portion **42** may be adjusted at different heights from the top surface **48**. As will be apparent, the configuration of funnel member **40** may be reversed with recessed portions formed along its length frictionally engaging protrusions formed about the edge of aperture **46**. As noted above, use of the funnel member **40** is optimal in that the upper portion **42** of the device **10** may be left exposed above the ground for capture of water, air and/or nutrients, through aperture **46** or in the absence of the top surface **48**.

With reference to FIG. **12**, the subterranean plant root water and air collection and delivery device **10** is shown prior to being coupled to the second identical subterranean plant root water and air collection and delivery device **10***b*. As discussed above, the bottom lip member **74** of the device **10** engages a top lip member **84***b* of the device **10***b* with the rib members **76** secured within indentations **86***b* of the second device **10***b*. Likewise, a third device (not shown) may be coupled to the top lip **84** of the device **10** or to a bottom lip member **74***b* of the device **10***b*. As shown in FIG. **13**, the devices **10** and **10***b* are coupled to one another in a serial fashion to increase the total depth to which water and air is collected and redirected. The device may also be placed in a horizontal direction to help facilitate horizontal flow of water and air. Preferably, the devices **10** and **10***b* each have a length of eighteen (18) inches. However, one skilled in the art will recognize that the length of the devices **10** and **10***b* may be varied for a particular application.

With reference to FIG. **14**, four subterranean plant root water and air collection and delivery devices **10***a*, **10***b*, **10***c* and **10***d* all having features common to device **10**, are illustrated in close proximity to roots **150** and the surround areas of a tree **152**. Devices **10***a* and **10***b* have been coupled to one another as illustrated in FIGS. **12** and **13** and buried in a substantially vertical manner below the ground surface **154**. Likewise, the device **10***c* has been buried in a substantially vertical manner below the ground surface **154** in another area adjacent to the roots **150**. The device **10***d* has been buried adjacent to device **10***c* in a substantially horizontal manner. Funnel members **40***a* and **40***c* have been

inserted within devices **10***a* and **10***c*, as represented in FIG. **11**, and extend a predetermined distance above the ground level **154**. A planter simply uses an auger or similar digging tool to dig a sufficiently large hole, places the devices **10***a*–**10***d* therein, and replaces a portion of the removed soil around the devices **10***a*–**10***d* leaving portions of the funnel members **40***a* and **40***c* exposed. As shown, the funnel member **40***c* funnels water **156** which is poured from a hand-pouring device **158** to the device **10***c*. Similarly, the funnel member **40***a* is used in conjunction with a pressurized watering device **160**, which delivers pressurized water and/or nutrients **159** to the devices **10***a* and **10***b*. As shown, the devices **10***a* through **10***c* are buried such that they extend through a top soil layer **170**, a clay/loam layer **172** and a clay layer **174**. As discussed above, ordinary ground water illustrated as lines **176** is commonly channeled through the top soil level **170**, which is well above the main portion of the roots **150**. As such, this ground water **176**, along with air and any supplied water, is collected and rerouted by the devices **10***a* through **10***c*, as illustrated by lines **177**, to the lower ground levels **172** and **174** and ultimately the area surrounding roots **150** of the tree **152**. The device **10***d* facilities the horizontal flow of water and air. As discussed above in conjunction with FIGS. **1–4**, the apertures **22**, **72** and **82** within each of the enclosures of devices **10***a* and **10***d* provide ingress and egress for the surrounding air and ground water **176** to and from within their interior volumes for redirection and delivery to the various ground levels **170**, **172** and **174** where the roots **150** located. In accordance with a preferred embodiment, a pressurized water and nutrients delivering member **180** is coupled to a coupling assembly **26***a*, which is identical to coupling assembly **26** of device **10**, for delivery of pressurized water **182** to the interior volumes of devices **10***a* and **10***b*. As with the air and surrounding ground water **176**, the devices **10***a* and **10***b* reroute the pressurized water **182** throughout the various ground levels **170**, **172** and **174**. The devices **10***a* through **10***d* each include porous insert members **24***a* through **24***d* for facilitating the collection and delivery of the air, ground water **176**, manually supplied water **156**, and the pressurized water **182** while preventing any ground material from entering the interior volumes of the devices **10***a* through **10***d*.

Next turning to FIG. **15**, subterranean plant root water and air collection and delivery devices **10***a*, **10***b* and **10***c* are shown coupled to one another and buried in a horizontal manner for delivering surrounding air and ground water **190** at a substantially constant depth below ground level **154**. The devices **10***a*–**10***c* are shown buried in close proximity to roots **192** of a bush or hedge **194**. Again, a pressurized water and nutrients delivery member **196** is coupled to a coupling assembly **26***c* for delivering pressurized water and nutrients **198** to the devices **10***a*–**10***c* and the roots **192**. As will be apparent from FIGS. **14** and **15**, any number of subterranean plant root water collection and delivery devices may be vertically and horizontally oriented in the ground for irrigating a predetermined area throughout various depths and soil conditions.

Lastly, with reference to FIG. **16**, a schematic illustration of various subterranean plant root water and air collection and delivery devices **10***a* through **10***h*, all having features common to device **10**, are shown integrated within an underground irrigation system **200** associated with a building **201**. The system **200** includes a pressurized water source **202** which delivers pressurized water via underground lines **204**, similar to lines **180** and **196**, to the devices **10***a* through **10***h*, as well as sprinkler heads **206***a* through **206***i*. The devices **10***a* through **10***h* are buried at predetermined depths in close proximity to the roots of plants **210***a* through **210***d* for efficiently collecting and delivering air, water and nutrients to the same. As will be apparent to one skilled in the art, the pressurized delivery line **204** may be in the form of hoses or threaded pipe members which are coupled to coupling assemblies **26***a* through **26***h* of the devices **10***a* through **10***h*. As discussed in conjunction with FIG. **14**, the devices **10***a* through **10***h* collect and reroute naturally flowing ground water and water from the pressurized water source **202** as well as nutrients and air to the roots of the plants **210***a* through **210***d*. Likewise, devices **10***a* through **10***h* collect and redirect a portion of the water supplied by the sprinkler heads **206***a* through **206***i* to the roots of the plants **210***a* through **210***d*.

Referring to FIG. **17**, an alternate embodiment of the subterranean plant root water and air collection and delivery device **250** is shown. The enclosure member **251** of the present embodiment preferably includes a body **252**, a top cap **256**, and a bottom cap **274** or other connectors as required and described herein. Generally cylindrical tube shaped body **252** is made of extruded plastic, such as polypropylene or other similar plastics, and may have additives included with the base material such that body **252** is biodegradable after a period of time while still being structurally sufficient prior to that time. The body includes a plurality of apertures **254** substantially about its entire surface. Body **252** may be provided in a wide range of precut lengths or can be provide in bulk and cut to a particular length at the site where it is being installed. The preferred embodiment of device **250** is approximately 18 inches long, as is the first embodiment.

A disk shaped top cap **256**, additionally shown in FIG. **18** includes an outer annular flange section **258** and is fastened to body **252** by fasteners **260** (described below). Cap **256** can be injection molded, vacuum formed, or made in any other appropriate fashion. Cap **256** has an inner flange section **262** coordinated with outer flange section **258** which forms an annular slot **264** into which a first end **266** of body **252** is inserted. An inner disk portion **267** of top cap **256** has a plurality of apertures **268** which allow for water and air flow therethrough. A funnel punch-out aperture **270** can be incorporated which accepts funnel member **40**, previously described in connection with the first embodiment. Structural contours, generally at **272**, may be incorporated into inner disk portion **267** to provide additional strength to top cap **256**, and to rigidly support funnel member **40**.

A top cap **256** where the funnel punch-out **270** has not been removed (not shown) can be used as a bottom cap if desired. Alternately, a unique bottom cap **274** can be utilized, as shown in FIGS. **17** and **19**. Bottom cap **274** includes an inner disk shaped portion **276** and a pair of generally parallel flanges **278** and **280** near the radially outer edge of disk portion **276**. Flanges **278** and **280** form annular slots **277** and **279**. Flanges **278** and **280** are generally perpendicular to inner disk **276** and extend on each side of the inner disk **276** as shown. This allows a second body **252***a* (not shown) to be attached to a second end **282** of the first body **252** by inserting second end **282** into slot **277** and inserting a first end **266***a* (not shown) of body **252***a* into slot **279**. Inner disk **276** has a plurality of apertures **283** so that water and air may flow from first body **252** to second body **252***a* or to the soil below. Inner disk **276** can also be constructed without any apertures (not shown) if there is a desire to prevent water and air flow to the ground below when the bottom cap **274** is used to cap a body which is not connected to a second or subsequent body.

Fasteners **260** used to secure the top and/or bottom cap, **256** and **274** respectively, to body **252** can be selected from

a wide range of fastening devices. Particularly, staples, rivets, screws, plastic one-way push pins (often referred to as christmas trees), plastic reusable push pins, and metal spring clips are all considered appropriate, as well as other similar retention devices.

The porous insert member **24** is insertable within and substantially occupies the interior volume of body **252**. Preferably insert member **24** is made from an open cell foam or structural non-woven material which provides some structural reinforcement for the body and which can be replaceable if necessary or desirable.

Referring to FIG. **20**, there is shown a sheet type porous insert member **24'**. A slow dissolving fertilizer spike **284**, which will provide additional nutrients to the surrounding soil and therefore the roots in the vicinity, can be wrapped within the sheet type porous insert member **24'** prior to insertion into body **252**. Alternately, the insert member **24** itself can be coated with a solution of slow dissolving fertilizer. When the spike **284** or the fertilizer coating is determined to be dissolved, the insert member **24** or **24'** can be removed and replaced with a fresh insert containing a fertilizer spike or having a fertilizer coating.

As in the first embodiment, the bodies of the present embodiment can be stacked or connected in a wide variety of arrangements. Bottom cap **274** is one means of connecting two sequential bodies. Another connector is shown in FIG. **21** and is referred to as through connector **286**. Through connector **286** is utilized when it is desirable to provide access to the interior volume of a subsequent body. This may be particularly useful if a fertilizer spike or fertilizer coated insert member is positioned down some distance below the surface of the ground in order to be located closer to the roots of a deep rooted plant. As shown, through connector **286** is constructed similar to that of the bottom cap **274**, having a pair of annular flanges **288** and **290** providing annular slots **292** and **293** which accept the second end **282** of body **252** and the first end **266***a* of second body **252***a*. The primary difference being that through connector **286** does not contain a center disk portion like bottom cap **274**.

Another connector which can be used in conjunction with the present embodiment is an angle connector **294** as shown in FIG.'S **22** and **23**. Angle connector **294** will typically but is not limited to being used where a vertical body is being connected to a horizontal body, as shown in FIG. **14** elements **10***c* and **10***d* for the prior embodiment. Angle connector **294** includes a first end **296** having a pair of annular flanges **298** and **300** which provide an annular slot **302** into which a first end **266***a* of second body **252***a* can be inserted. The outer flange **298** extends as shown to provide a contoured mating surface **304** which coordinates with the cylindrical side surface **306** of first body **252**. Depending upon the angle, contoured mating surface **304** will change slightly to match with cylindrical side surface **306** of first body **252** at that particular angle. A 90 degree angle connector is shown for purposes of illustration since it is believed to be the connector of this type which would predominantly be used. However, other angles, such as 30 degrees or 45 degrees, may be common when positioning a sequence of bodies horizontally along a hedge or row of bushes which themselves have an angle portion. The angle connectors can be held in place by fasteners **260** as previously discussed, or may be retained by wraps **308** (such as plastic wire ties or the like) which surround first body **252** and attach to upstanding flanges **310** on angle connector **294**.

The present embodiment also provides for connection to a pressurized water supply system or other pipes or hoses, by attaching a variety of nipples. A push-on type nipple member **314**, similar to that of **34** or **36**, is shown in FIG.'S **24** and **25**. As shown, nipple member **314** has a central aperture **316** which extends through a curved base portion **318**. A hose barb portion **320** is configured to receive and secure a pressurized hose (not shown) which is a part of an irrigation system. Curved base portion **318** provides apertures **322** for connecting nipple member **314** to body **252** using fasteners **260** similar to those used to attach top cap **256** and bottom cap **274** to body **252**. Curved portion **318** also provides retention tabs **324**, projecting from a first surface **326** which can be used in conjunction with wraps **308** (such as plastic wire ties or the like) which are wrapped around body **252** and secure nipple member **314** in place. Positioning tabs **330** can also be incorporated from a second side **332** of curved portion **318**. Positioning tabs **330** are sized and spaced such that they will extend through apertures **254** in body **252** and help prevent rotation or movement of nipple member **314**.

Threaded nipples, having either interior or exterior threads, or both, can be used in place of push-on type nipple member **314**. The retention members and structure would be similar to that of nipple member **314** and are readily interchangeable with the push-on nipple member **314**.

The foregoing discloses and describes merely exemplary embodiments of the present invention. One skilled in the art will readily recognize from such discussion and from the accompanying drawings and claims, that various changes, modifications and variations can be made therein without departing from the spirit and scope of the present invention as defined by the following claims.

What is claimed is:

1. A subterranean plant root water and air collection and delivery device, comprising:

an enclosure member including a body having a first end and a second end, a top cap fastened to the first end of the body, and a bottom cap fastened to the second end of the body, said body including a plurality of apertures and having an interior volume within which surrounding ground water and air is collected; and

a porous insert member insertable within the interior volume of the enclosure member and substantially occupying the entire interior volume for facilitating collection and delivery of the ground water and air to a root area of at least one plant while substantially preventing surrounding ground material from entering the interior volume of the enclosure member, whereby the enclosure member is buried at a predetermined depth in close proximity to the root area of the at least one plant such that the plurality of apertures provide ingress for the surrounding air and ground water to the interior volume along a length of the enclosure member and whereby the plurality of apertures provide egress along the length for delivering the water and air to an area adjacent the root area.

2. The plant root water and air collection and delivery device of claim **1** wherein the enclosure member further comprises:

a connector fastened to the second end of the body, the connector providing for attachment of a second body.

3. The plant root water and air collection and delivery device of claim **2** wherein the connector is substantially impermeable to water.

4. The plant root water and air collection and delivery device of claim **2** wherein said connector includes a plurality of apertures therein for the transgression of water and air therethrough.

5. The plant root water and air collection and delivery device of claim 2 wherein the connector includes a central through hole formed therein for passage of the porous insert member.

6. The plant root water and air collection and delivery device of claim 2 wherein the connector includes an outer flange and an inner flange defining a slot therebetween for engaging said second body.

7. The plant root water and air collection and delivery device of claim 2 wherein the connector is angled to a pre-selected degree.

8. The plant root water and air collection and delivery device of claim 1 wherein the top cap includes a punch out apparatus for selectively coupling with a funnel member for funneling external substances to the internal volume of the body.

9. The plant root water and air collection and delivery device of claim 1 wherein the top cap includes structural contours for providing added structural rigidity to the top cap.

10. The plant root water and air collection and delivery device of claim 1 wherein the top cap includes an outer flange and an inner flange defining a slot therebetween for engaging the body.

11. The plant root water and air collection and delivery device of claim 1 wherein the top cap includes a plurality of apertures for delivering water and air therethrough.

12. The plant root water and air collection and delivery device of claim 1 wherein the top cap includes a central throughhole for passage of the porous insert member therethrough.

13. The plant root water and air collection and delivery device of claim 1 wherein the bottom cap includes an outer flange and an inner flange defining a slot therebetween for engaging the body.

14. The plant root water and air collection and delivery device of claim 1 wherein the bottom cap includes a plurality of apertures therein for delivering water and air therethrough.

15. The plant root water and air collection and delivery device of claim 1 wherein the bottom cap includes a central throughhole formed therein for passage of the porous insert member therethrough.

16. The plant root water and air collection and delivery device of claim 1 wherein the porous insert member includes a wrapped sheet configuration.

17. The plant root water and air collection and delivery device of claim 1 wherein the porous insert member includes a fertilizer member therein for providing nutrients to the root area of the at least one plant.

18. The plant root water and air collection and delivery device of claim 17 wherein the fertilizer member includes a coating deposited on the porous insert member.

19. The plant root water and air collection and delivery device of claim 17 wherein the fertilizer member includes a discrete device wrapped within the porous insert member.

20. The plant root water and air collection and delivery device of claim 1, further comprising:

coupling means for coupling a pressurized water delivery member to the enclosure member such that water is delivered to the interior volume and ultimately to the roots of the at least one plant.

21. The plant root water and air delivery device of claim 1, wherein the top cap includes a plurality of intersecting slots defining an opening therethrough for insertion of an external substance delivery device.

22. A subterranean plant root water and air collection and delivery device, comprising:

an extruded enclosure member including a body having a first end and a second end, a top cap fastened to the first end of the body, and a bottom cap fastened to the second end of the body, said body including a plurality of apertures, the body having an interior volume, the interior volume and the apertures providing a path within which surrounding ground water and air is collected and delivered to a root area of at least one plant, the apertures of the body being of a size to substantially prevent surrounding ground material from entering the interior volume of the enclosure member, whereby the enclosure member is buried at a predetermined depth in close proximity to the root area of the at least one plant such that the plurality of apertures provided ingress for the surrounding air and ground water to the interior volume along a length of the enclosure member and whereby the plurality of apertures provides egress along the lengthy for delivering the water and air to an area adjacent to root area.

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